FISHERY MANAGEMENT INVESTIGATIONS

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2010 Upper Snake Region Annual Fishery Management Report

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ABSTRACT

Fifty experimental gill nets (26 sinking, 24 floating) were set at standard locations to assess fish populations and relative abundance in Henrys Lake during May 2010. Gill net catch rates (fish-per-net-night) for Yellowstone cutthroat trout *Oncorhynchus clarkii bouvieri* (10.1) and brook trout *Salvelinus fontinalis* (3.6) were above the long term average (1991-2009) of 5.7 and 1.8, respectively, while hybrid trout (rainbow trout *O. mykiss* x Yellowstone cutthroat trout) catch rates (2.4) were below the long term average of 4.0. Mean relative weight (W_r) of Yellowstone cutthroat trout, hybrid trout, and brook trout (across all length classes) was 96, 105, and 100 mm, respectively, which is similar to values from 2009 and continued decreasing trend that started in 2005. Median catch rate for Utah chub *Gila atraria* decreased from 8 fish per net in 2009 to 2.5 in 2010. Six percent (31 of 505) of gill net caught cutthroat trout were adipose clipped, indicating that natural reproduction is contributing to the Henrys Lake trout population. Zooplankton surveys indicate a high abundance of larger preferred size zooplankton forage in Henrys Lake and that competition is not limiting zooplankton abundance.

Stomach contents from 872 trout were examined to determine if trout in Henrys Lake are preying on Utah chub. Overall, fish comprised 13% of the trout diet by weight in Henrys Lake, compared to <1% of the diet in 2004. Although only one Utah chub was identified in trout stomach samples, the increase in fish found in the trout diet indicates they may be preying upon Utah chub to a greater degree than previously believed.

A creel survey of the ice fishery was conducted during the last nine days of November 2010 resulting in an estimated 3,750 hours of effort with a total catch of 5,562 trout (1.48 fish/hour). Catch rate was highest for cutthroat trout (0.74 fish/hour), followed by brook trout (0.47 fish/hour) and hybrid trout (0.27 fish/hour). Overall, we estimated 775 trout harvested (405 cutthroat trout, 258 brook trout, and 112 hybrid trout), with a release rate of 86%, which was higher than the release rate observed in our last season-long creel survey (83%) conducted in 2009.

Dissolved oxygen levels were monitored to assess the possibility of a winterkill event from December 2009 through March 2010. Based on depletion estimates, we predicted dissolved oxygen levels would remain adequate for fish survival; therefore, we did not operate the aeration system during 2010.

The spawning operations at Henrys Lake Hatchery Creek facility produced over 2 million eyed Yellowstone cutthroat trout eggs and nearly 400,000 eyed hybrid trout eggs in 2010. Yellowstone cutthroat trout ascending the fish ladder to the hatchery averaged 461 mm total length (TL), whereas hybrid trout averaged 561 mm. Sterility tests from Henrys Lake hybrid trout production indicate a 100% induction rate, although a small number (<10) of hybrid males are captured at the ladder each year. Pathology tests did not detect any viral or bacterial presence in ovarian fluids. Similar to the gill net survey, 90 of the 4,253 (2%) returning Yellowstone cutthroat trout checked at the hatchery were adipose clipped, further indicating that natural reproduction is contributing to the population within Henrys Lake.

Riparian fencing was installed and maintained on Duck, Targhee, Howard and Timber creeks, as well as around the south and north side of the county boat dock. Fish screens were operated and maintained on 11 irrigation diversions on Howard, Targhee, and Duck creeks.

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INTRODUCTION

Henrys Lake, located in eastern Idaho in the Greater Yellowstone Ecosystem, has provided a recreational trout fishery since the late 1800s (Van Kirk and Gamblin 2000). A dam was constructed on the outflow of the natural lake in 1924 to increase storage capacity for downstream irrigation. This dam increased total surface area to 2,630 ha, with a mean depth of 4 m. The now-inundated lower portions of tributary streams historically provided spawning habitat for adfluvial Yellowstone cutthroat trout *Oncorhynchus clarkii bouvieri*, prompting concerns for recruitment limitations. To mitigate for this potential loss of recruitment, the Idaho Department of Fish and Game (IDFG) acquired a private hatchery on Henrys Lake and began a fingerling trout stocking program that continues today. The lake supports a popular fishery for native Yellowstone cutthroat trout, hybrid trout (rainbow trout *O. mykiss* x Yellowstone cutthroat trout) and brook trout *Salvelinus fontinalis*, with an average of approximately 130,000 hours of annual angling effort. Angler surveys determined Henrys Lake to be the most popular lentic fishery in the state (IDFG 2001). Since 1923, IDFG has stocked a total of over 84 million Yellowstone cutthroat trout, 10 million hybrid trout and nearly 4 million brook trout. Stocking ratios averaged 84% Yellowstone cutthroat trout, 12% hybrid trout, and 4% brook trout from 1950 to 2010. Beginning in 1998, all hybrid trout were sterilized prior to release to reduce the potential for hybridization with native Yellowstone cutthroat trout. Although hybridization was not a concern with brook trout, only sterile fingerlings have been stocked since 1998 (with the exception of 50,000 fertile fish in 2003) to reduce the potential for naturally reproducing brook trout to compete with native salmonids.

Anglers view Henrys Lake as a quality fishery capable of producing large trout. As early as the mid-1970s, 70% of interviewed anglers preferred the option of catching large fish even if it meant keeping fewer fish (Coon 1978). The management of Henrys Lake has emphasized restrictive harvest consistent with providing a quality fishery as opposed to liberal bag limits that are more consistent with a yield fishery. In 1984, fisheries managers created specific, quantifiable objectives to measure angling success on Henrys Lake. Based on angler catch rate information and harvest data collected during creel surveys conducted between 1950 and 1984, managers thought it was possible to maintain catch rates of 0.7 trout per hour, with a size objective of 10% of harvested Yellowstone cutthroat trout exceeding 500 mm. These objectives remain in place today. To evaluate these objectives, annual gill net monitoring occurs in May, immediately after ice off and prior to the fishing season, while creel surveys are conducted on a three to five year basis.

STUDY SITE

Henrys Lake is located 1,973 m above sea level, between the Henrys Lake Mountains and the Centennial mountain range, approximately 29 km west of Yellowstone National Park. The lake is 6.4 km long and 3.2 km wide, and covers approximately 2,630 ha. The outlet of Henrys Lake joins Big Springs Creek to form the headwaters of the Henrys Fork Snake River (Figure 1).

OBJECTIVES

To obtain current information on fish population and limnological characteristics for fishery management decisions on Henrys Lake, and to develop appropriate management recommendations.

METHODS

Population Monitoring

As part of routine population monitoring, we set gill nets at six standardized locations in Henrys Lake from May 14 to May 27, 2010 for a total of 50 net nights (Figure 1). Gill nets consisted of either floating or sinking types measuring 46 m by 2 m, with mesh sizes of 2 cm, 2.5 cm, 3 cm, 4 cm, 5 cm and 6 cm bar mesh. Nets were set at dusk and retrieved the following morning. We identified captured fish to species and recorded total lengths (TL). We calculated catch rates as fish per net night and also calculated 95% confidence intervals. We used a one-way analysis of variance (ANOVA) to detect differences in gill net catch rates in 2010 compared to the previous 10 years. When differences were found, we used least significant difference (LSD) pairwise comparisons to identify years in which gill net catch rate differed. We also used a Kruskal-Wallis one-way analysis of variance to analyze gill net catch rates of Utah chub *Gila atraria,* as this species demonstrates schooling behavior, and are likely not randomly distributed.

We examined all captured Yellowstone cutthroat trout *Oncorhynchus clarkii bouvieri* for adipose fin clips as part of our evaluation of natural reproduction. To estimate contributions to the cutthroat trout population from natural reproduction, we calculated the ratio of marked to unmarked fish collected in annual gill net surveys and the same ratio analysis for trout captured ascending the fish ladder on Hatchery Creek. Ten percent of all stocked Yellowstone cutthroat trout are marked with an adipose fin clip prior to stocking, therefore, a ratio of 10% or greater indicates low levels of natural reproduction.

We removed the saggital otoliths of all trout caught in our gill nets for age and growth analysis. After removal, all otoliths were cleaned on a paper towel and stored in individually-labeled envelopes. Ages were estimated by counting annuli under a dissecting microscope at 40x power. Otoliths were submerged in water and read in whole view when clear, distinct growth rings were present. We sectioned, polished and read otoliths in cross-section view with transmitted light when the annuli were not distinct in whole view. Aged fish were then plotted against length using a scatter plot, and any outliers were selected, re-read, and the ages corroborated by two readers.

Relative weights (W_r) were calculated by dividing the actual weight of each fish (in grams) by a standard weight (W_s) for the same length for that species multiplied by 100 (Anderson and Neumann 1996). Relative weights were then averaged for each length class (< 200 mm, 200-299 mm, 300-399 mm and fish > 399 mm). We used the formula

$$\log W_s = -5.194 + 3.098 \log TL \text{ (Anderson 1980)}$$

to calculate relative weights of hybrid trout (rainbow trout *O. mykiss* x Yellowstone cutthroat trout),

$$\log W_s = -5.189 + 3.099 \log TL$$

for cutthroat trout (Kruse and Hubert 1997) and

$$\log W_s = -5.186 + 3.103 \log TL$$

for brook trout *Salvelinus fontinalis* (Hyatt and Hubert 2001).

We calculated proportional stock density (PSD) and relative stock density (RSD - 400) to describe the size structure of game fish populations in Henrys Lake. We calculated PSD for Yellowstone cutthroat trout, hybrid trout, and brook trout using the following equation:

$$PSD = \frac{\text{number} \geq 300 \text{ mm}}{\text{number} \geq 200 \text{ mm}} * 100$$

We calculated RSD-400 for Yellowstone cutthroat trout, hybrid trout, and brook trout using the following equation:

$$RSD\text{-}400 = \frac{\text{number} \geq 400 \text{ mm}}{\text{number} \geq 200 \text{ mm}} * 100$$

The criteria used for PSD and RSD-400 values for Yellowstone cutthroat trout, hybrid trout, and brook trout populations was based on past calculations and kept consistent for comparison purposes. This methodology is used on other regional waters to provide comparison between lakes and reservoirs throughout the Upper Snake Region. We also calculated RSD-500, using the same equation as above, but used the number of fish greater than 500 mm as the numerator.

Zooplankton samples were collected at three locations (Targhee Creek, Outlet, and Wild Rose; Figure 1) on July 14. We preserved zooplankton in denatured ethyl alcohol at a concentration of 1:1 (sample volume : alcohol). After ten days in alcohol, phytoplankton were removed from the samples by re-filtering through a 153: mesh sieve. The remaining zooplankton were blotted dry with a paper towel and weighed to the nearest 0.1 g. Biomass estimates were corrected for tow depth and reported in g/m. We measured competition for food (or cropping impacts by fish) using the zooplankton productivity ratio (ZPR) which is the ratio of preferred (750:) to usable (500:) zooplankton. We also calculated the zooplankton quality index (ZQI) to account for overall abundance of zooplankton using the formula ZQI = (500: + 750:) * ZPR (Teuscher 1999).

Diet Analysis

We analyzed the stomach contents of Yellowstone cutthroat trout, hybrid trout, and brook trout collected during standard population monitoring (May gill netting) to determine diet composition and assess predation on Utah chub by trout. We collected and analyzed additional stomach samples from fish captured by angling and gill netting on July 26 and August 4. Stomachs were removed, stored in individually labeled vials, and preserved with 10% formalin. For each stomach, we identified individual food items, separated items by genus and then counted and weighed each genus to the nearest gram. Identified food items were summarized as percent weight of the total diet and percent of the total contents by number. In instances where extremely high densities of a particular food item were encountered (i.e., Daphnia and occasionally scuds), we weighed and counted a sub-sample of the stomach contents and expanded the results to the total amount contained within the stomach. Diet contents were summarized by species and compared to results from 2004 (Garren et al. 2006).

Creel Survey

Henrys Lake hatchery personnel conducted a creel survey from November 21 through November 30 to collect effort, catch and harvest information from nine days of ice fishing on Henrys Lake. We generated instantaneous counts using randomly selected dates and times, and counted anglers twice per day from a point overlooking the lake with the aid of binoculars and spotting scopes. Counts were completed within one half hour. Creel clerks interviewed anglers at access sites and by roving throughout the day to obtain method of fishing, time spent fishing, and number, species and length of fish caught. We analyzed data using standard methodology and the Idaho Department of Fish and Game creel census program.

Water Quality

We measured winter dissolved oxygen concentrations, snow depth, ice thickness and water temperatures at five established sampling sites (Pittsburg Creek, County Boat Dock, Wild Rose, Outlet, and Hatchery) on Henrys Lake on January 12, 21, and 28, 2010 (Figure 1). Holes were drilled in the ice with a gas-powered ice auger prior to sampling. We used a YSI model 550-A oxygen probe to collect dissolved oxygen readings at ice bottom and at subsequent one-meter intervals until the bottom of the lake was encountered. Dissolved oxygen mass is calculated from the dissolved oxygen probe's mg/L readings converted to total mass in g/m^3. This is a direct conversion from mg/L to g/m^3 ($1000\ L = 1 m^3$). The individual dissolved oxygen readings at each site are then summed to determine the total available oxygen within that sample site. To calculate this value, we used the following formula:

$$\text{Avg (ice bottom+1m)} + \text{Sum (readings from 2m to lake bottom)} = \text{total } O_2 \text{ mass}$$

The total mass of dissolved oxygen at each sample site is then expressed in g/m^2 (Barica and Mathias 1979). Data are then natural logarithm (ln*)* transformed for regression analysis. We used linear regression to estimate when oxygen levels would deplete to the critical threshold for fish survival (10.0 g/m^2).

Spawning Operation

We operated the Hatchery Creek fish ladder for the spring spawning run from February 20 through April 30. Fish ascending the ladder were identified to species and counted. We measured total length for a sub-sample (10%) of each group. All Yellowstone cutthroat trout were examined for the presence of adipose fins to evaluate natural reproduction. Yellowstone cutthroat trout were produced using ripe females spawned into seven-fish pools and fertilized with pooled milt from seven males. Hybrid trout were produced with Yellowstone cutthroat trout eggs from Henrys Lake and rainbow trout milt obtained from the Ennis National Hatchery in Ennis, Montana. Hybrid trout were sterilized by inducing a triploid condition using pressure to shock the eggs post-fertilization. Once hybrid trout eggs reached 47 minutes and 45 seconds post-fertilization, eggs were placed in the pressure treatment machine at 10,000 psi and held at this pressure for 5 minutes. A random sample of 60 hybrid fry was sent to the IDFG Eagle Fish Health Lab to test induction rates of sterilization. Hybrid trout eggs were shipped to Mackay Hatchery for hatching, rearing and subsequent release back into Henrys Lake and other Idaho waters. Additional fertile hybrid eggs were shipped to American Falls Hatchery for hatching, rearing, and subsequent release into Salmon Falls Reservoir. Yellowstone cutthroat trout eggs were shipped to Mackay for hatching, rearing and release back into Henrys Lake.

We collected ovarian fluids from all pooled egg lots of Yellowstone cutthroat trout to detect the presence of bacterial disease. We also collected 25 random viral samples from combined egg pools. A mixed-sex group of 60 adult Yellowstone cutthroat trout were sacrificed and sent to the Eagle Fish Health Laboratory for various disease testing, including bacterial kidney disease, whirling disease, and furunculosis. For more information on disease testing and results, contact the IDFG fish health lab in Eagle, ID (IDFG, Eagle Fish Health Laboratory, 1800 Trout Road, Eagle, ID 83616).

Riparian Fencing and Fish Screening

Electric fencing has been in place along the selected reaches of the Henrys Lake shoreline and its tributaries since the early 1990's to protect riparian areas from grazing livestock. We installed fencing, solar panels, batteries, and connections during May 2010 at ten sites on Duck, Howard, Targhee, and Timber creeks. Fencing was also installed along the shoreline north and south of the county boat ramp. We routinely checked fencing during the summer and fall for proper voltage and function. Fences were let down and prepared for winter in November 2010.

Fish screens are located on eleven irrigation diversions on tributaries streams to Henrys Lake. Screens were routinely maintained, cleaned and checked for proper operation during the summer and fall months of 2010.

RESULTS

Population Monitoring

We collected 1,227 fish in 50 net nights of gill net effort. Catch composition was 41% Yellowstone cutthroat trout, 10% hybrid trout, 13% brook trout, and 36% Utah chub (Figure 2). Yellowstone cutthroat trout ranged from 157 to 575 mm TL (mean: 336 mm; Figure 3), hybrid trout 177 to 634 mm (mean: 442 mm; Figure 4), and brook trout 168 to 515 mm (mean: 365 mm; Figure 5). Mean length at age 3 was 453 mm, 521 mm, and 465 mm for Yellowstone cutthroat trout, hybrid trout, and brook trout, respectively (Table 1). Proportional stock density (PSD) for all species was high (brook trout: 84, hybrid trout: 94, and cutthroat trout: 81; Table 2). Relative stock density (RSD-400) was highest for hybrid trout (58) followed by brook trout (21) and cutthroat trout (20), while RSD-500 was 36, 6, and 1 for hybrid trout, brook trout, and cutthroat trout, respectively. Mean relative weight for all trout species, across all sizes, ranged from 96 to 105 (Table 2) and relative weight of Yellowstone cutthroat trout size classes ranged between 86 and 98 (Figure 6). Results from our gill net surveys showed 31 of 505 (6%) Yellowstone cutthroat trout were adipose-clipped (Table 3).

Gill net catch rates were highest for Yellowstone cutthroat trout at 10.1 fish per net night, followed by brook trout at 3.3, and hybrid trout at 2.4 fish per net night (Figure 7). We found significant differences in Yellowstone cutthroat trout gill net catch rates between 2000 and 2010 (ANOVA: $F_{10,305} = 9.87$, $p<0.0001$). Post-hoc least significant difference (LSD) tests showed that gill net catch rate of Yellowstone cutthroat trout in 2010 was significantly greater than catch rates from all years aside from 2007 and 2008. Brook trout catch rate in 2010 was similar to 2009, and significantly greater than catch rates during 2002 – 2006 (ANOVA: $F_{10,305} = 6.28$, $p<0.0001$). Hybrid trout catch rates were below average, and were significantly less than three of the last ten years' catch rates (2000-2002, 2004, and 2007) (ANOVA: $F_{10,306} = 4.79$, $p<0.0001$). The median catch rate of Utah chub was 2.5 fish per net night, down from 8.0 in 2009 (Figure 8), and was significantly less than 2006 (Kruskal-Wallis ANOVA: $H = 52.2$, $p < 0.0001$).

Zooplankton monitoring showed that preferred size zooplankton is not being cropped by fish (ZPR = 0.84) and that abundance of quality zooplankton is relatively high in Henrys Lake (ZQI = 0.66). Although the ZQI results are relatively high compared to other regional water bodies, the amount of available zooplankton observed in 2010 is lower than previous surveys (see *Regional Lakes Zooplankton chapter* for more details).

Diet Analysis

We analyzed stomach contents of 872 trout (549 Yellowstone cutthroat trout, 194 brook trout, and 129 hybrid trout) from Henrys Lake. Overall, diet composition (by weight) across all species was dominated by leeches (36%), followed by Daphnia (24%), scuds (14%), and fish (13%), with the remaining 13% of the diet comprised of other items (Table 4). Yellowstone cutthroat trout diet was dominated by Daphnia (46%), followed by scuds (23%), leeches (16%), chironomids and fish (5% each), and 5% was a combination of other items. Brook trout diet was dominated by fish (42%), followed by leeches (23%), chironomids (10%), snails (9%), and Daphnia (5%), with the remaining 11% of the diet a combination of other items. Hybrid trout diet was dominated by leeches (66%), followed by Daphnia (11%), scuds (9%), snails (6%), fish and chironomids (3% each), with mollusks comprising the additional 2%. Diet composition by total number of items found in stomach contents was dominated by Daphnia (92%), followed by chironomids (6%), and scuds (2%) for all trout species combined (Table 5). Daphnia comprised 95%, 91%, and 54% (by number of items) of the cutthroat, hybrid, and brook trout diet, respectively.

Fish dominated the brook trout diet (42% by weight), and were also present in the cutthroat trout (5%) and hybrid trout (3%) samples. Fish comprised 13% of the weight of all stomach contents in 2010 (Table 4). A total of 32 fish were found in the 872 diet samples analyzed in 2010 (17 in 549 cutthroat samples, 9 in 129 hybrid trout samples, and 6 in 194 brook trout samples). Of the 32 fish found in diet samples, 17 were unable to be identified to species, while the remainder were identified as sculpin (n=14) and Utah chub (n=1) (Table 6).

Trout diet analysis in 2010 showed changes from 2004, with leeches, fish, and snails increasing from zero percent of the overall trout diet (by weight) in 2004, to 36, 13 and 5 percent, respectively in 2010 (Table 4). Daphnia also increased from 9 percent of the total diet in 2004 to 24 percent in 2010. Chironomids decreased from 56% of diet by weight in 2004 to 5% in 2010, while scuds decreased from 34% to 14%.

Creel Survey

We estimated 3,750 angler hours of effort with a total catch of 5,562 trout, for a catch rate of 1.48 fish per hour (fish/hour) during the November ice fishery (Table 7). Catch rates were highest for Yellowstone cutthroat trout (0.74 fish/hour), followed by brook trout (0.47 fish/hour) and hybrid trout (0.27 fish/hour). We estimated 14% (n = 775) of the total catch was harvested. Of the 775 fish harvested, catch composition was 52% (n = 405) Yellowstone cutthroat trout, 33% (n = 258) brook trout, and 15% (n = 112) hybrid trout. Mean size was 469 mm, 425 mm, and 509 mm for harvested cutthroat, brook, and hybrid trout, respectively. Of the Yellowstone cutthroat trout harvested, 15% (n = 61) exceeded 500 mm, and no cutthroat trout over 600 mm were harvested. Of the hybrid trout harvested, 39% (n = 44) were greater than 500 mm, and 4% (n = 5) were greater than 600mm. Thirty-three percent (33%) (n = 85) of the harvested brook trout were greater than 430 mm. The majority of anglers observed during the ice fishery on Henrys Lake were residents (92%). Gear type used was primarily bait (65%), with lures comprising the remainder of the fishing effort (35%).

Water Quality

Between January 12 and January 28, total dissolved oxygen diminished from 36.4 g/m^2 to 35.3 g/m^2 at the Pittsburgh Creek site and from 24.5 g/m^2 to 20.8 g/m^2 at the hatchery site. Total dissolved oxygen levels increased at three sites, from 21.8 g/m^2 to 24.7 g/m^2 at the County dock, 28.5 g/m^2 to 31.6 g/m^2 at the Wild Rose site, and 18.0 g/m^2 to 18.7 g/m^2 at the Outlet site (Table 8). In the winter of 2009-2010, analysis of the dissolved oxygen depletion model predicted dissolved oxygen would remain above the level of concern throughout the winter (Figure 9), therefore aeration was not deployed.

Spawning Operation

We collected 4,370 Yellowstone cutthroat trout (2,220 males [51%] and 2,150 females [49%]) that ascended the hatchery spawning ladder between February 18 and April 28, 2010. Yellowstone cutthroat trout male and female total lengths averaged 462 and 459 mm, respectively, with a combined mean length of 461 mm. We also collected 130 hybrid trout (125 males [96%] and 5 females [4%]). Hybrid trout males averaged 561 mm.

We collected 3,488,260 green eggs from 1,231 Yellowstone cutthroat trout females for a mean fecundity of 2,834 eggs per female. Eyed Yellowstone cutthroat trout eggs totaled 2,057,871 for an overall eye-up rate of 67%. We shipped all eyed Yellowstone cutthroat trout eggs to Mackay Hatchery where they were hatched and reared.

We collected 840,140 green eggs from 308 female Yellowstone cutthroat trout (fecundity = 2,728 eggs per female) for hybrid trout production. Eyed hybrid trout eggs totaled 387,903 for an overall eye-up rate of 46%. Lot 1 and part of Lot 2 eggs were treated to induce sterility. The other component of Lot 2 eggs were not treated to induce sterility and remained fertile as they were bound for Salmon Falls Reservoir. Hybrid eye-up was 36% in Lot 1 and 47% in Lot 2 sterile component and 79% Lot 2 fertile component. We shipped 275,000 sterile hybrid eggs to Mackay for hatching, rearing, and subsequent release into Henrys Lake and 100,806 fertile hybrid eggs to American Falls for release into Salmon Falls Reservoir. Two spawn days were devoted to production of hybrid eggs during the 2010 spawn take. Sterilization induction rates for the sterile hybrid production component indicated 100% (60/60) success for the triploid condition.

Riparian Fencing and Fish Screening

Electric fencing functioned well during the year and riparian infringements by cattle were rare. One new riparian fence was installed along riparian areas of Duck Creek, a tributary to Henrys Lake. The fence was installed along a previously fenced riparian buffer area. The new fence serves as a replacement to the old fence that was in need of replacement. The fencing construction and funding was a result of a collaborative effort between the Forest Service, Fremont County and IDFG.

The fish screens functioned well during the summer of 2010. The new screens on Targhee and Howard Creek that had been installed during the summer of 2008, and the screen installed during the summer of 2009 on Duck Creek functioned well and will be a benefit both to improved fry survival and facility labor costs.

DISCUSSION

During our 2010 annual gill net surveys, Yellowstone cutthroat trout comprised 41% of the overall species composition. This marks the first time since 2002 when a species other than Utah chub dominated the overall species composition. Gill net catch rates (fish per net night) for Yellowstone cutthroat trout and brook trout were above the long term average, while hybrid trout catch rates were below the long term average. Although the stocking rate for hybrid trout was 20% below average in 2007, it was 7% and 21% above average in 2008 and 2009, yet gill net catch rates are still low, and younger hybrid trout are underrepresented in the length-frequency distribution of the gill net catch. This may be related to misidentification between smaller hybrid trout and cutthroat trout, which would artificially increase the catch rate of cutthroat trout and decrease the hybrid trout catch rate.

Utah chub median gill net catch rate in 2010 declined to 2.5 fish per net from 8 in 2009 and was significantly less than the catch rates observed in 2006. While it appears that Utah chub abundance may be declining, concerns over the impact to the trout fishery still remain. Yellowstone cutthroat trout relative weights have steadily declined since 2004, indicating that competition for food resources may be occurring. While cutthroat trout relative weight in 2010 was similar to 2009, declines may not be entirely related to competition with Utah chub. Yellowstone cutthroat trout relative weight may be declining due to increased intraspecific competition as increased natural reproduction contributes to the overall population within the lake.

The ratio of marked to unmarked Yellowstone cutthroat trout collected in gill net surveys and in the spawning operation (6% and 2% respectively; 3% overall) indicates that natural reproduction is contributing to the Henrys Lake fishery. Additionally, increased catch rates in gill nets for cutthroat trout combined with overall decreased relative weights, suggest that the cutthroat trout population in Henrys Lake has increased, likely due to recruitment/natural reproduction. Increased recruitment may be due to numerous tributary stream habitat improvement projects that have occurred over the past 10+ years, including riparian protection, instream passage improvements, and irrigation canal screening.

The primary purpose of the diet analysis was to determine if any trout species in Henrys Lake were preying on Utah chub and if so, to what extent. Trout diet analysis in 2010 showed considerable differences compared to diets analyzed in 2004 (Garren et al. 2006). Only two fish were documented in 417 samples collected in 2004, while 32 fish were found in 872 samples, and fish comprised 42% of the brook trout diet by weight during 2010. Overall, fish comprised 13% of the trout diet in 2010, while fish were <1% of the trout diet in 2004. Varying rates of digestion made identification of fish in diet samples difficult, with only 15 of the 32 samples identified to species. Of those identified, sculpin (*Cottus* spp.) were the predominant species preyed upon. One Utah chub was positively identified as a prey item found in a hybrid trout stomach sample documenting that at least some trout will forage on Utah chub. Earlier research documented fish, particularly sculpin, as a large portion of the diet of trout in Henrys Lake; Irving (1953) found fish comprised 6% of the cutthroat trout diet, while Jeppson (1973) documented fish comprising 8, 9, and 30% of the cutthroat, hybrid, and brook trout diet, respectively, and Spateholts (1984) found sculpin comprised 14% of the brook trout diet. This earlier research had not documented the presence of Utah chub in Henrys Lake, but referenced the main forage fish species as sculpin, redside shiner *Richardsonius balteatus*, and dace (longnose *Rhinichthys cataractae* and speckled *R. osculus*). Although sculpin were the dominant fish prey species in these studies, the amount of samples was relatively small (Irving [1953]: cutthroat = 116, brook = 19, hybrid = 10; Spateholts [1984]: brook = 102). Jeppson's (1972) work was the most comprehensive, with 300, 154, and 150 cutthroat, hybrid, and brook trout stomach samples, respectively. Jeppson also noted diet by month, and showed fish prey comprised a larger portion of the trout diet in late summer through fall, with fish comprising 87% of the brook trout diet in August, while cutthroat and hybrid trout fish foraging peaked in September and October at 26% and 13% of the total diet, respectively. The seasonal changes in diet composition (likely due to changes in available prey abundance) documented by Jeppson should be considered in future diet sampling to determine if trout in Henrys Lake are preying on Utah chub. This, combined with the results of our 2010 diet sampling, indicates that the potential for trout predation on Utah chub exists, but future sampling should occur throughout the season to document changes in diet composition and potentially document periods in which predation on Utah chubs is more prevalent.

During the 2010 ice fishery, anglers harvested each species in nearly identical proportion to their overall catch, indicating that they aren't harvesting or selecting for any species disproportionately to their abundance. As expected, anglers are selecting for larger fish; this was most evident in Yellowstone cutthroat trout where the mean total length of fish harvested by anglers was 133 mm larger than the mean total length of fish captured in gill nets. Hybrid trout and brook trout harvested were 67 and 60 mm larger, respectively, than those captured in gill nets. This is consistent with our 2009 creel survey and gill net data, when over the course of the entire season, angler harvested cutthroat trout, hybrid trout, and brook trout were 76, 34, and 129 mm larger, respectively, than those captured in gill nets.

The creel survey conducted during the nine days of ice fishing in November revealed the second highest catch rate on record (1.48 fish/hour vs. 1.70 fish/hour in 1984 in the open water fishery), but also the highest release rate observed (86%). The release rate observed in the 2010 ice fishery was similar to that seen in the 2009 creel survey (83%), which included the entire season (May through November). The average size of fish harvested was similar to that observed in 2009 during the open water fishery. Conversely, brook trout comprised a considerably larger portion of the catch composition (33%) than seen in recent creel surveys. This is likely related to multiple consecutive years of increased brook trout stocking, and possibly the foraging behavior of brook trout (i.e aggressiveness). This same trend was observed in the mid- to late-1970's, when brook trout comprised 9 – 14 % of the total fish stocked, and provided a 10 – 33% of the total angler catch. Catch rates during the 2010 ice fishery were higher than recent season-long creel surveys, but the harvest rate is similar to that of the past 30 years. With annual hatchery contributions of nearly 1.6 million trout, and seemingly increased natural reproduction, the harvest of less than 800 fish during the 2010 ice fishery is inconsequential to the overall fishery within Henrys Lake.

MANAGEMENT RECOMMENDATIONS

1. Continue annual gill net samples at 50 net nights of effort.
2. Collect otolith samples from all trout species; use for cohort analysis and estimates of mortality/year class strength and compare to previous years.
3. Continue winter dissolved oxygen monitoring over a longer time frame, from December through February, and implement aeration when necessary.
4. Continue to monitor Utah chub densities and evaluate potential impacts to trout with increased densities of chubs.
5. Collect monthly stomach samples from trout to determine diet composition, seasonal changes, and possible predation on Utah chub.

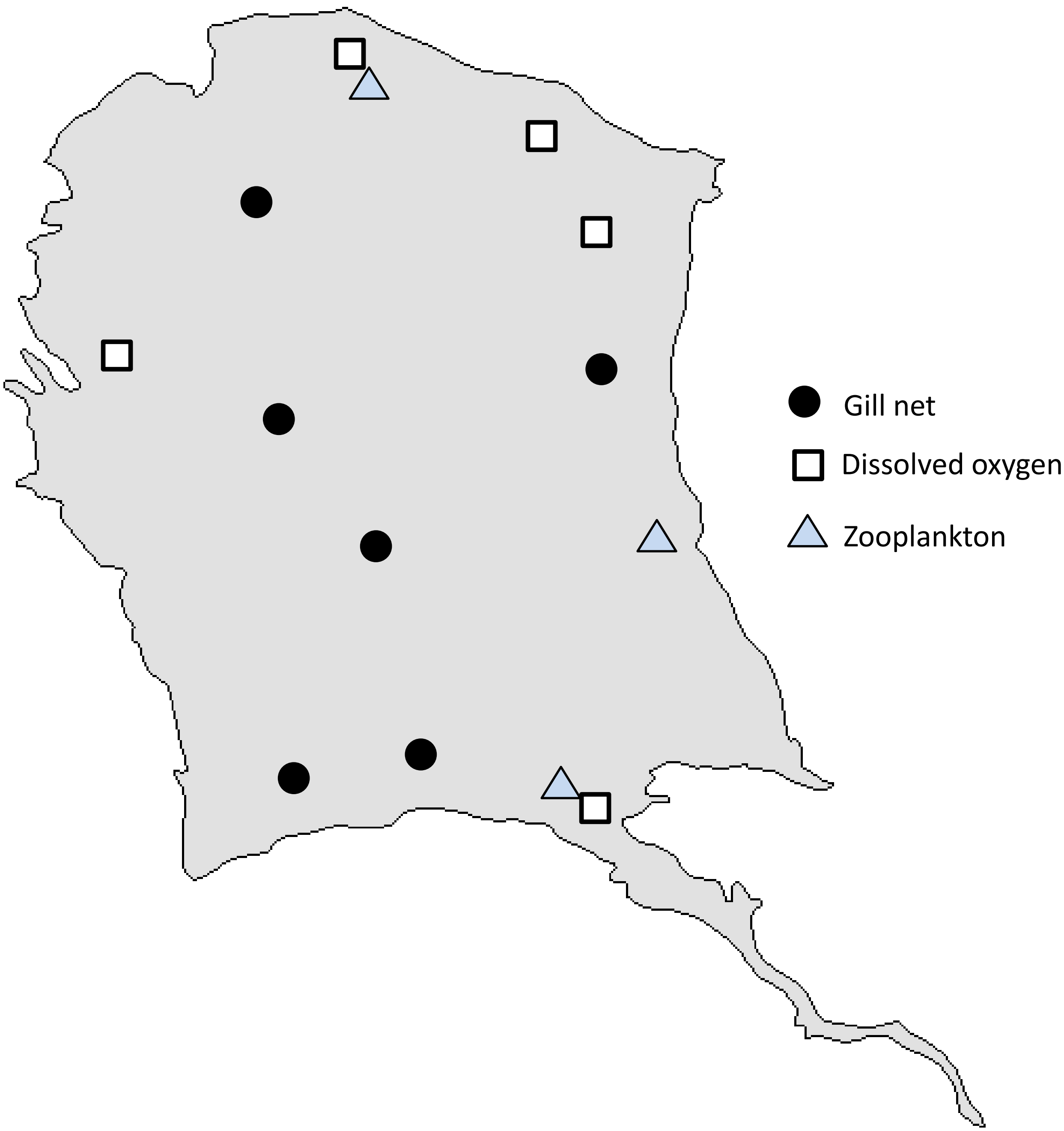

Figure 1. Spatial distribution of gill net, dissolved oxygen, and zooplankton monitoring sites in Henrys Lake, Idaho, 2010.

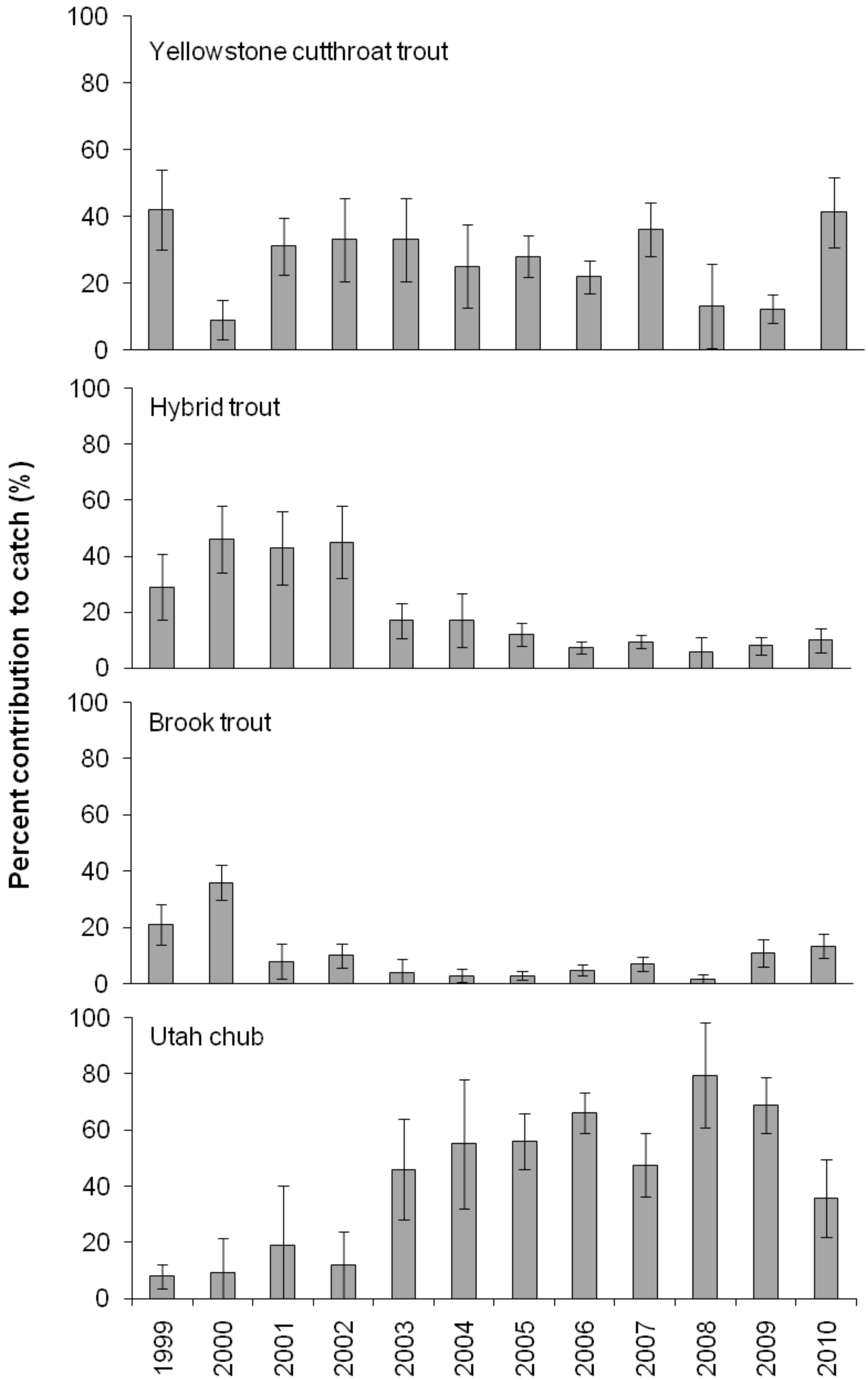

Figure 2. Relative abundance of Yellowstone cutthroat trout, hybrid trout, brook trout, and Utah chub caught in gill nets in Henrys Lake, Idaho between 1999 and 2010. Error bars represent 90% confidence intervals.

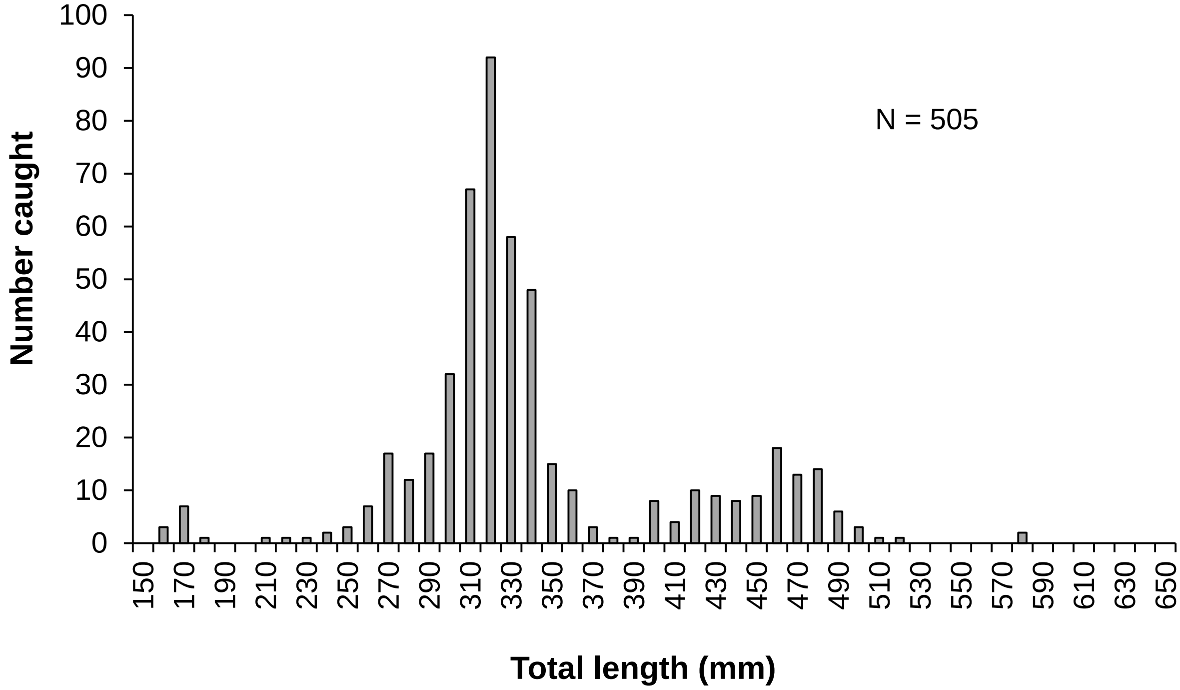

Figure 3. Yellowstone cutthroat trout length frequency distribution from gill nets set in Henrys Lake, Idaho, 2010.

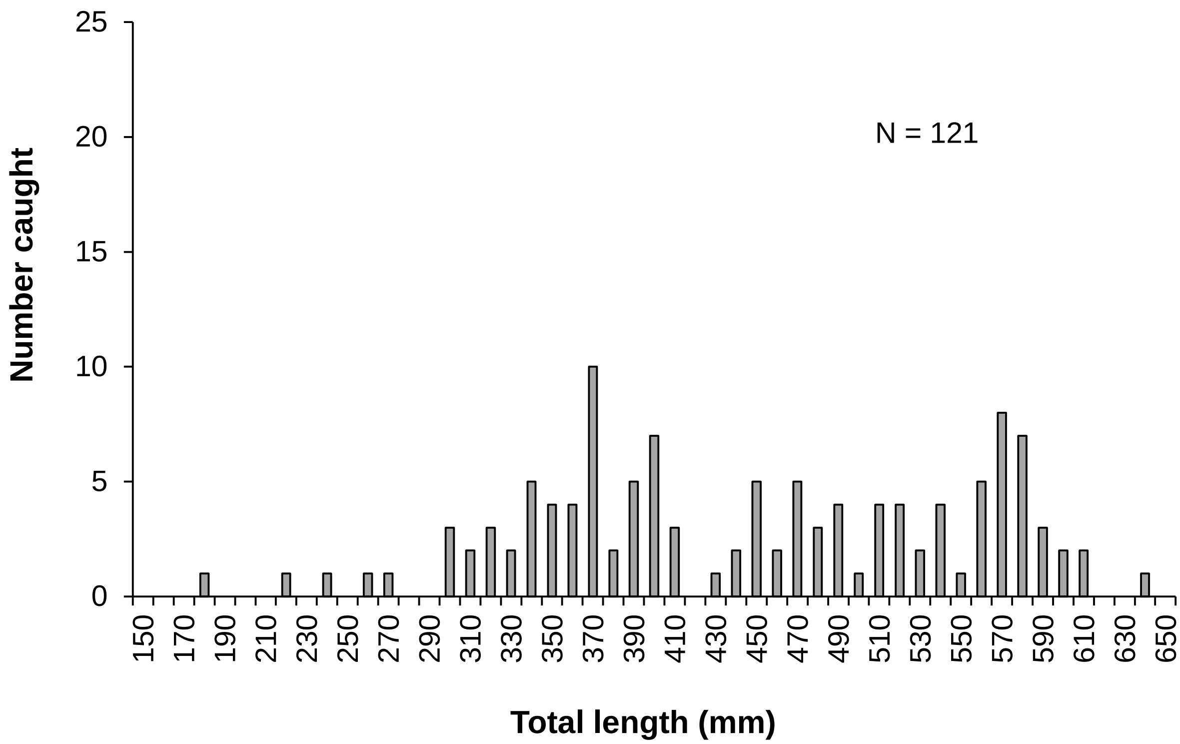

Figure 4. Hybrid trout length frequency distribution from gill nets set in Henrys Lake, Idaho, 2010.

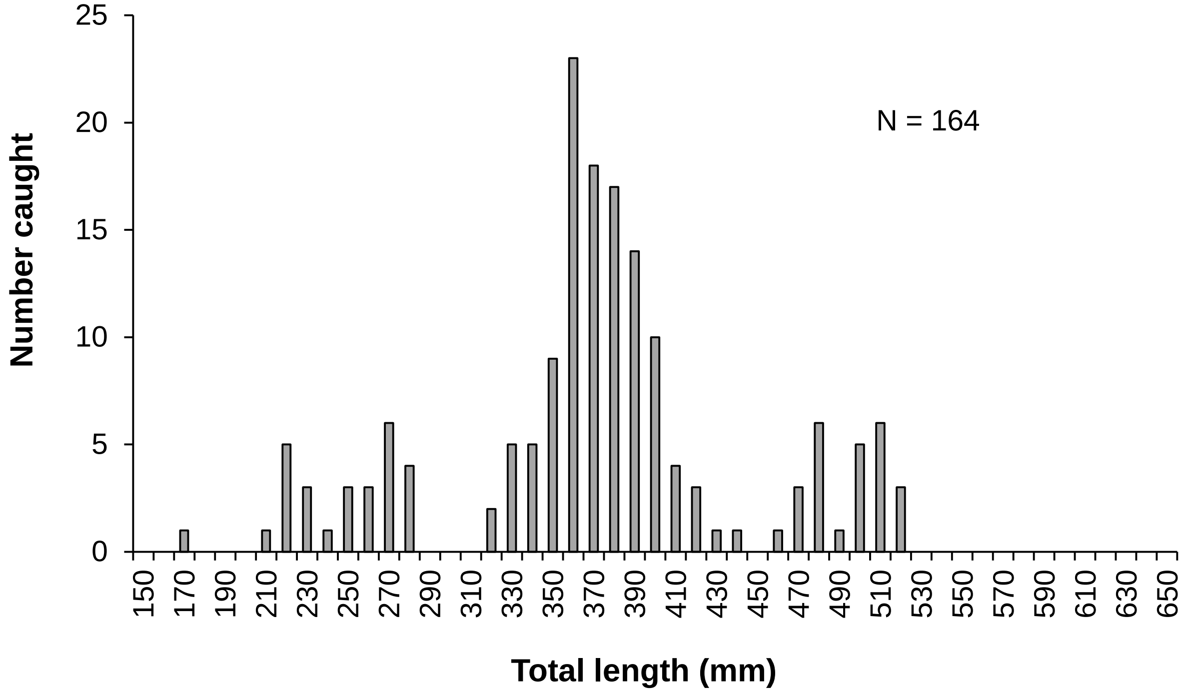

Figure 5. Brook trout length frequency distribution from gill nets set in Henrys Lake, Idaho, 2010.

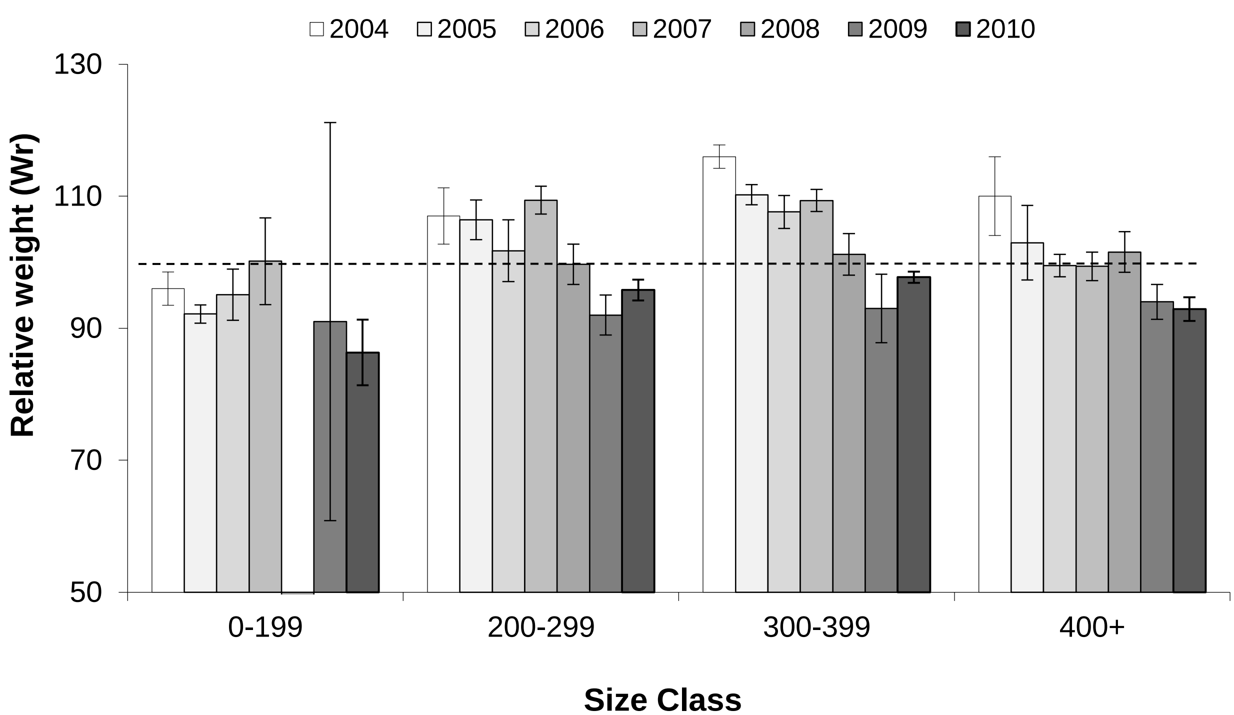

Figure 6. Relative weights (Wr) for Yellowstone cutthroat trout in Henrys Lake, Idaho 2004-2010. Error bars represent 95% confidence intervals.

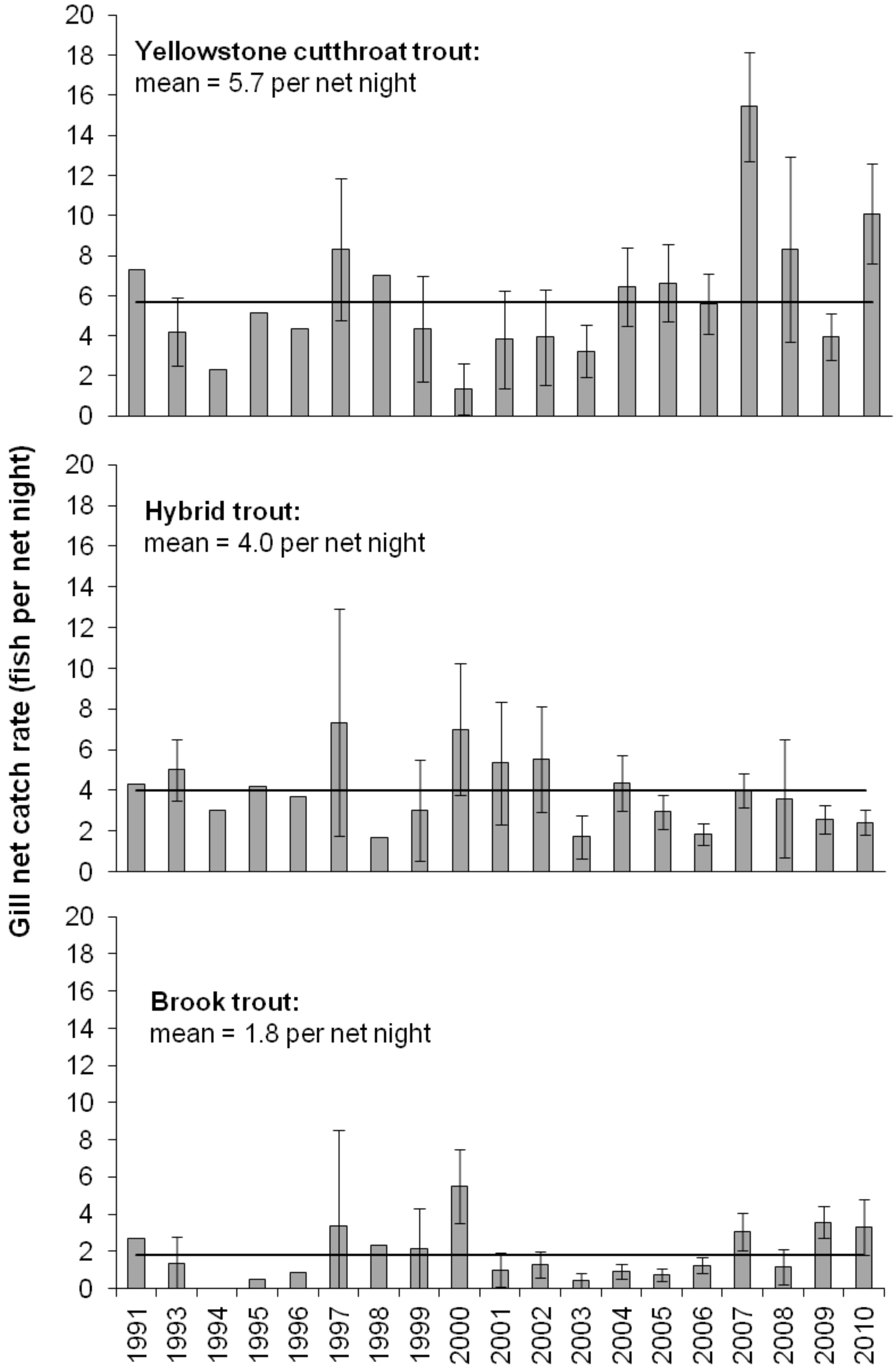

Figure 7. Gill net catch rates of Yellowstone cutthroat trout, hybrid trout, and brook trout from Henrys Lake, Idaho, 1991 to 2010. Error bars represent 95% confidence intervals. The solid line represents long term mean gill net catch rates.

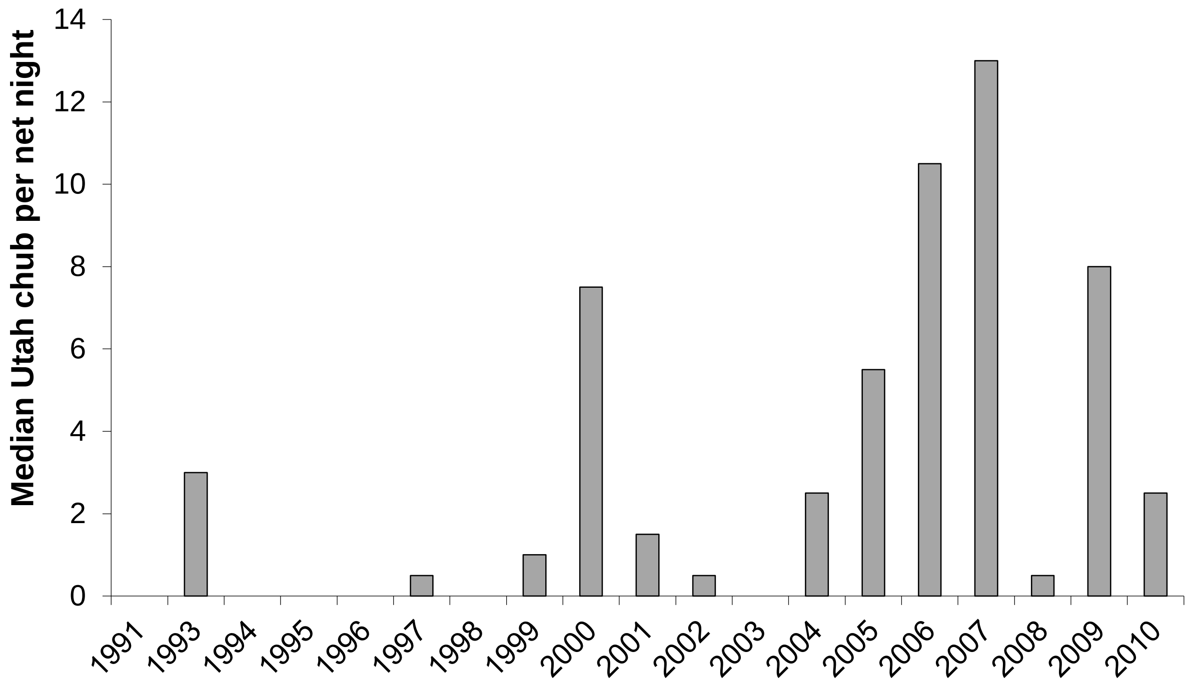

Figure 8. Median Utah chub catch rates in gill nets set in Henrys Lake, Idaho, 1993 to 2010.

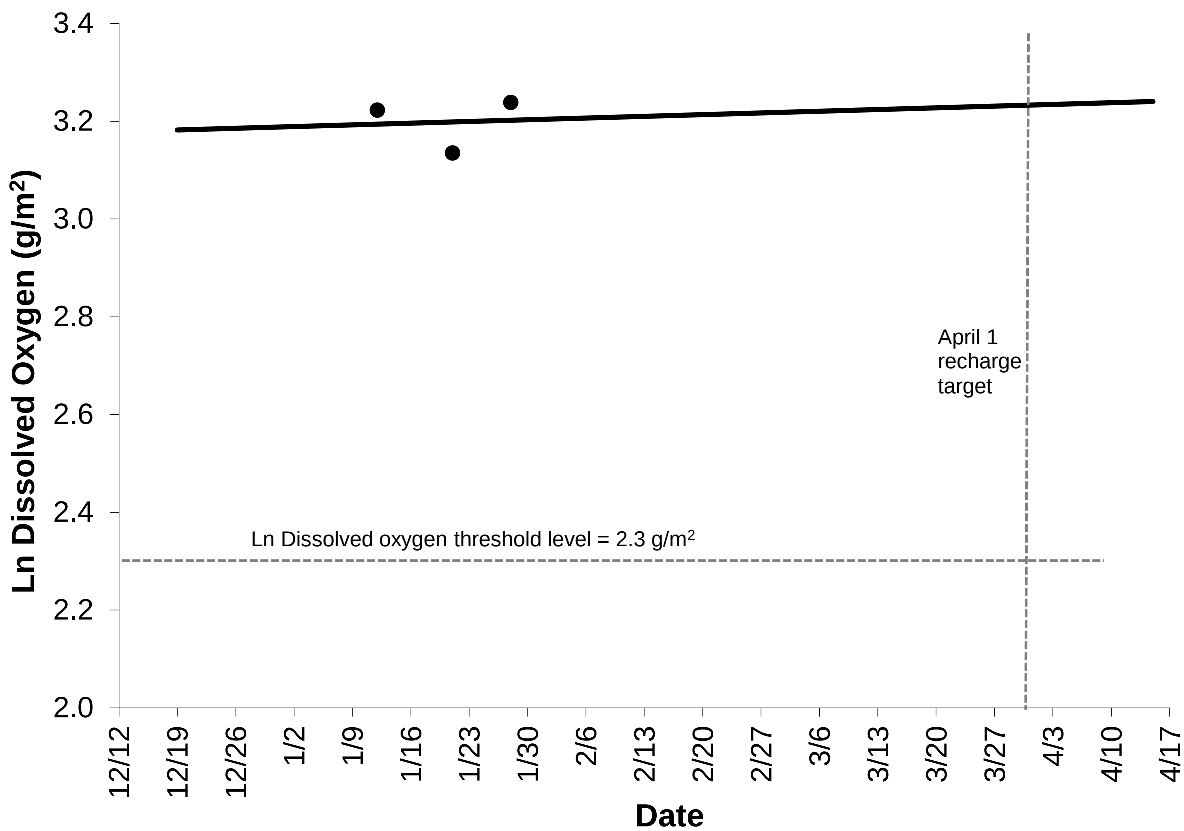

Figure 9. Mean dissolved oxygen from all sample locations and estimated lake-wide oxygen depletion rate for Henrys Lake, Idaho, 2009-2010.

Table 1. Mean length at age data from trout caught with gill nets in Henrys Lake, Idaho 2010. Ages were estimated using otoliths.

Species	Mean Length (mm) at Age			
	1	2	3	4
Yellowstone cutthroat trout	216	329	453	--
(No. Analyzed)	(19)	(33)	(26)	(0)
Hybrid trout	284	377	521	572
(No. Analyzed)	(14)	(29)	(29)	(4)
Brook trout	275	352	465	469
(No. Analyzed)	(33)	(19)	(17)	(3)

Table 2. Stock density indices (PSD and RSD-400) and relative weights (Wr) for all trout species collected with gill nets in Henrys Lake, Idaho 2010. Sample size (*n*) for relative weight values is noted in parentheses.

	Brook trout (*n*)	**Hybrid trout (*n*)**	**Yellowstone cutthroat trout (*n*)**
PSD	84	94	81
RSD-400	21	58	20
RSD-500	6	36	1
Wr			
<200 mm	84 (1)	90 (1)	86 (11)
200 – 299 mm	93 (26)	111 (7)	96 (93)
300 – 399 mm	102 (103)	103 (44)	98 (303)
>399 mm	103 (34)	106 (69)	93 (98)
Mean	100	105	96

Table 3. Fin clipping data from Yellowstone cutthroat trout (YCT) stocked in Henrys Lake, Idaho. Annually, ten percent of stocked YCT receive an adipose fin clip. Fish returning to the Hatchery ladder and fish captured in annual gillnet surveys are examined for fin clips.

Year	No. Clipped	No. checked at Hatchery	No. detected	Percent clipped	No. checked in gillnets	No. detected	Percent clipped
1996	100,290	--	--	--	--	--	--
1997	123,690	178	5	3%	--	--	--
1998	104,740	--	--	--	--	--	--
1999	124,920	160	20	13%	--	--	--
2000	100,000	14	1	7%	--	--	--
2001	99,110	116	22	19%	--	--	--
2002	110,740	38	7	18%	--	--	--
2003	163,389	106	37	35%	273	47	17%
2004	92,100	--	--	--	323	28	8%
2005	85,124	2,138	629	29%	508[a]	55	11%
2006	100,000	2,455	944	39%	269[a]	20	8%
2007	139,400	--	--	--	770	70	9%
2008	125,451	4,890	629	13%	100	10	10%
2009	138,253	4,184	150	4%	91	9	10%
2010	132,563	4,253	90	2%	505	31	6%

[a] Includes fish from gill net samples and creel survey.

Table 4. Diet composition for trout collected in Henrys Lake, Idaho, 2010 and 2004. Figures presented are percent of contents by weight.

	Brook trout		**Hybrid trout**		**Yellowstone cutthroat trout**		**Total**	
	2004 n=29	2010 n=194	2004 n=154	2010 n=129	2004 n=233	2010 n=549	2004 n=632	2010 n=872
Scuds	41	4	41	9	22	23	34	14
Vegetation	0	1	0	0	0	0	0	0
Leech	1	23	0	66	0	16	0	36
Chironomid	56	10	47	3	71	5	56	5
Mayfly	0	0	0	0	0	0	0	0
Daphnia	2	5	12	11	6	46	9	24
Damsel	0	0	0	0	0	1	0	0
Fish	0	42	0	3	0	5	0	13
Fish egg	0	0	0	0	0	0	0	0
Bivalve	0	0	0	2	0	0	0	1
Snail	0	9	0	6	0	2	0	5
Caddis	0	4	0	0	1	0	1	1
Other	0	2	0	0	0	2	0	1

Table 5. Diet composition for trout collected in Henrys Lake, Idaho, 2010 and 2004. Figures presented are percent of contents by number.

	Brook trout		**Hybrid trout**		**Yellowstone cutthroat trout**		**Total**	
	2004 n=29	2010 n=194	2004 n=154	2010 n=129	2004 n=233	2010 n=549	2004 n=632	2010 n=872
Scuds	17	3	7	3	6	2	7	2
Vegetation	0	0	0	0	0	0	0	0
Leech	0	1	0	1	0	0	0	0
Chironomid	41	35	14	5	35	3	21	6
Mayfly	0	4	0	0	0	0	0	0
Daphnia	41	54	79	91	60	95	72	92
Damsel	0	0	0	0	0	0	0	0
Fish	0	0	0	0	0	0	0	0
Fish egg	0	0	0	0	0	0	0	0
Bivalve	0	0	0	0	0	0	0	0
Snail	0	1	0	0	0	0	0	0
Caddis	0	0	0	0	0	0	0	0
Other	0	3	0	0	0	0	0	0

Table 6. Fish identified in stomach samples collected from brook trout (BKT), hybrid trout (HYB), and Yellowstone cutthroat trout (YCT) in Henrys Lake, 2010.

	Species			
	Sculpin	Utah chub	Unknown	Total
BKT	2	0	4	6
HYB	5	1	3	9
YCT	7	0	10	17
	14	1	17	32

Table 7. Annual estimates of angler effort, catch and harvest collected from creel surveys on Henrys Lake, Idaho.

							Catch Composition			% Exceeding Goals			Mean Size (mm)			Residency (%)	
Year	Effort (*1,000)	No. Caught (*1,000)	No. Harvested (*1,000)	Total CR[a]	Harvest CR[a]	% Released	YCT	HYB	BKT	YCT (500 mm)	HYB (500 mm)	BKT (450 mm)	YCT	HYB	BKT	Res	Non Res
1950	17	--	12.3	0.82	0.72	12	77	0	23	--	--	--	--	--	--	--	--
1951	27.9	--	12.3	0.49	0.44	12	80	0	20	--	--	--	--	--	--	--	--
1971	102.2	--	36.7	0.36	0.36	0	70	14	16	--	--	--	--	--	--	--	--
1972	83.8	--	27	0.32	0.32	0	69	19	12	--	--	--	--	--	--	50	50
1975	86.3	--	29.9	0.38	0.35	10	89	0	11	--	--	--	--	--	--	49	51
1976	68.1	36.7	18.7	0.54	0.27	49	81	<1	19	2	--	2	426	--	371	50	50
1977	66.1	29.2	16.5	0.44	0.25	44	71	<1	29	4	--	4	420	339	362	50	50
1978	85.3	40.5	25.5	0.48	0.3	32	48	20	33	9	--	9	429	389	381	51	49
1979	93.9	29.8	18.7	0.32	0.2	37	35	42	24	11	8	6	452	456	378	53	47
1980	68.5	14.6	9.2	0.21	0.14	37	31	59	10	11	16	5	429	459	391	67	33
1981	65.9	14.2	7.5	0.21	0.11	47	30	54	16	13	11	19	445	450	389	--	--
1982	63.3	28.7	7.1	0.45	0.11	75	62	25	13	7	17	25	416	451	405	--	--
1983	96	122	25.4	1.23	0.23	81	84	9	7	3	14	17	388	448	392	64	36
1984	162.9	271	47	1.7	0.29	83	92	5	3	1	5	30	388	427	393	64	36
1985	125.7	159.4	37.9	1.3	0.3	76	92	4	4	0	0	0	378	416	364	60	40
1986	172.8	154.7	67.7	0.9	0.39	55	85	14	1	0	12	0	407	441	364	--	--
1987	150.2	81.1	35.7	0.54	0.24	56	60	34	6	5	26	3	436	447	371	--	--
1988	100.5	81.6	19.5	0.82	0.2	76	49	39	12	8	17	21	430	432	383	--	--
1989	340	262.5	103.7	0.77	0.31	60	50	45	5	4	11	10	404	435	387	--	--
1990	344.2	174.5	63.1	0.51	0.18	64	53	41	5	2	24	0	427	461	433	--	--
1991	124.4	50.5	16.1	0.36	0.13	68	49	49	2	21	35	20	460	473	369	--	--
1992	115.5	53	12.2	0.45	0.11	72	38	52	10	27	42	22	452	474	417	--	--
1993	144.3	92.5	26.7	0.64	0.18	71	76	21	3	7	35	23	410	485	382	--	--
1994	177.8	116.6	21	0.66	0.12	82	52	43	5	5	15	29	418	437	425	71	29
1995	172.6	99.3	20.6	0.58	0.12	79	37	60	3	9	21	27	434	442	432	65	35
1997	228.9	127.7	32.4	0.54	0.25	74	51	46	3	5	15	9	423	434	389	--	--

Table 7. (continued)

Year	Effort (*1,000)	No. Caught (*1,000)	No. Harvested (*1,000)	Total CR[a]	Harvest CR[a]	% Released	Catch Composition YCT	HYB	BKT	% Exceeding Goals YCT (500 mm)	HYB (500 mm)	BKT (450 mm)	Mean Size (mm) YCT	HYB	BKT	Residency (%) Res	Non Res
1999	228	148.6	27.3	0.65	0.12	72	22	65	13	8	12	16	442	447	405	--	--
2001	165.8	93.3	17.7	0.56	0.11	81	35	58	7	12	57	43	447	503	452	--	--
2002	--	--	--	0.41	--	--	42	49	9	17	71	50	454	540	462	--	--
2003	108.5	16.9	5.4	0.17	0.05	68	45	51	4	18	65	82	476	543	464	68	32
2005	95	45	8.9	0.48	0.1	80	53	42	5	4	38	0	413	497	379	66	34
2009	124.6	78.9	13.8	0.63	0.11	83	49	41	10	5	50	55	450	502	419	75	25
2010[b]	3.8	5.6	0.8	1.48	0.21	86	52	15	33	15	39	33	469	509	425	92	8

[a] = Total catch rate and harvest rate expressed as fish per hour.
[b] = Creel survey conducted from 11/21/10 through 11/30/11.

Table 8. Dissolved oxygen (DO) (mg/l) levels recorded in Henrys Lake, Idaho winter monitoring 2009-2010.

Location	Date	Snow depth (cm)	Ice thickness (cm)	DO Ice bottom	DO 1 meter	DO 2 meters	DO 3 meters	Total g/m^2
Pittsburg Creek	1/12/10	20	44	11.3	10.6	9.6	6.8	36.1
	1/21/10	25	42	11.4	10.3	8.3	5.8	30.7
	1/28/10	38	44	13.2	11.8	10.0	6.3	35.3
County Boat Ramp	1/12/10	17	51	10.9	8.9	8.2	3.7	21.8
	1/21/10	19	51	10.5	7.6	7.1	4.0	22.5
	1/28/10	43	41	12.7	9.1	8.0	4.9	24.7
Wild Rose	1/12/10	20	38	10.98	10.3	9.7	6.9	28.5
	1/21/10	23	38	10.5	10.0	8.6	5.0	24.7
	1/28/10	33	38	11.1	10.4	8.3	4.8	31.6
Outlet Bay	1/12/10	19	33	11.2	10.5	5.6	1.7	18.0
	1/21/10	20	46	10.6	10.1	5.7	1.7	17.7
	1/28/10	33	33	12.8	11.6	5.4	1.2	18.7
Hatchery	1/12/10	8	41	10.9	9.3	7.7	4.7	24.5
	1/21/10	30	41	10.5	8.2	6.9	3.8	21.2
	1/28/10	30	41	11.1	8.2	6.8	3.5	20.8

ISLAND PARK RESERVOIR

ABSTRACT

We used curtain gill nets at six locations in Island Park Reservoir to determine kokanee *Oncorhynchus nerka* presence and depth distribution near the intake structure of the Island Park Hydroelectric Project to get a preliminary assessment of entrainment potential through the dam. In 10 net nights of gill net effort, we captured 195 kokanee (mean total length: 181 mm), 82% of which were captured in sinking gill nets. Of the kokanee captured in sinking gill nets, 71% were captured in the lower half of the net (bottom 3m of the water column), indicating that most kokanee found near Island Park Dam may be susceptible to entrainment into the intake structures.

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INTRODUCTION

Island Park Reservoir has been recognized as a quality recreational fishery since the early 1950's, supporting as much as 176,000 hours of angling effort annually, with catch rates averaging 0.45 fish per hour. Rainbow trout *Oncorhynchus mykiss* have provided the bulk of angler catch, with kokanee salmon *O. nerka*, brook trout, mountain whitefish *Prosopium williamsoni* and Yellowstone cutthroat trout *O. clarkii bouvieri* adding to the creel. Supplemental stockings have played a large role in the management of the reservoir fishery, which is primarily supported by hatchery releases of rainbow trout and kokanee salmon, although some spawning by both occurs in the Henrys Fork Snake River upstream of the reservoir. Annual rainbow trout fingerling stockings have averaged 467,000 over the past 71 years and have been as high as 2.5 million fish in 1959. Nearly 120,000 kokanee were stocked into Island Park Reservoir in 1944-1945, followed by 144,000 stocked into Moose Creek in 1957. These initial stockings resulted in a self-sustaining spawning run of kokanee in Moose Creek, upon which IDFG established a kokanee trapping facility to collect eggs for stocking in other waters. The Moose Creek kokanee trap was operated intermittently between 1963 and 1975, with over 5 million eggs collected in 1969. Between 1976 and 1979, Island Park Reservoir was drawn down to near record levels on two occasions, and treated with rotenone during the 1979 draw down. Annual kokanee fry stocking of nearly 500,000 fish in 1981, 1982, and 1984 re-established the run, and trapping at Moose Creek resumed in 1987, though most fish were passed over the trap to spawn naturally. The trap was operated again in 1990 and 1991, but low numbers of fish were captured. Drought conditions and low populations prohibited trap operations in 1992-1994. In 1995, over 200,000 eggs were again collected at the Moose Creek trap, but future trap operations were ceased due to low returns combined with the identification of other egg sources (Deadwood Reservoir). The trap was installed once again in 2003, but too few fish were captured to provide the necessary egg collection, so all were passed over the trap to spawn naturally.

Historically, the proliferation of non-game fish, primarily Utah chub *Gila atraria* and Utah sucker *Catostomus ardens*, had been blamed for declines in the sport fishery in Island Park Reservoir, therefore, several rotenone projects had been undertaken to reduce overall non-game fish abundance and improve angler catch rates. The efficacy of these treatments was questioned as early as 1982, when Ball et al. (1982) observed that the three chemical rehabilitations of Island Park Reservoir over the previous 25 years had not been successful at permanent or long-term eradication of non-game species, and improvements in the trout fishery had been the result of increased stocking levels, especially noticeable with the large introductions of catchable rainbow. Ball et al. (1982) further noted that the observed declines in the rainbow trout fishery two to four years after treatment are the result of decreased levels of hatchery inputs and are not due to the increase in chub and sucker densities. The most recent chemical treatment of the reservoir, conducted in 1992, yielded similar results, with catch rates not improving upon levels prior to the treatment (Gamblin 2002). More recently, Garren et al (2008) found that non-game fish exceed pre-rotenone treatment levels within five years following treatments and that angler catch rates within five years following rotenone treatments were not significantly different than catch rates prior to treatments, suggesting that rotenone treatments have no effect on improving angler catch rate.

Island Park Reservoir is operated as an irrigation storage reservoir for agricultural users downstream, and is therefore subject to fluctuations in annual water levels. Reservoir storage normally begins at the close of irrigation season in October, and lasts until demand for water increases, typically in late May or early June. Reservoir storage levels can fluctuate from the lowest storage level recorded of 270 acre-feet in 1992, to nearly 90% full (121,561 acre-feet), as seen in 1997. Recent analysis of reservoir storage indicates that water storage is related to gill net catch rates. Garren et al (2008) found a significant relationship between reservoir carryover and salmonid gill net catch rate the following year by examining spring gill net catch and the previous years' reservoir level; years following low reservoir storage typically show a reduction in sport fish densities in gill nets. Although the relationship between carryover and gill net catch rates has been identified, it is unclear what exactly is impacting salmonid populations: increased mortality due to lost habitat associated with drawdowns, or entrainment through the dam due to increased outflow. Maiolie and Elam (1998) documented kokanee losses as high as 90% of the entire Dworshak Reservoir population due to entrainment, and explained this loss due to kokanee distribution throughout the reservoir. During their research, congregations of all age-classes of kokanee were found near Dworshak Dam, making them susceptible to entrainment due to high volumes of water being released through the dam. Consistent with the observed decline in kokanee populations, Island Park Dam was modified in 1994 with a new intake structure to facilitate power generation as part of the Island Park Hydroelectric Project (Ecosystems Research Institute 1994), thereby altering the location of water withdrawals from the reservoir. Although both intake structures are located at the reservoir bottom, the hydroelectric intake is 206m east of the pre-1994 intake structure, and closer to the river channel. The hydroelectric facility is capable of handling up to 960 cfs, therefore throughout most of the year; the entire outflow is being routed through the hydroelectric facility intake. To prevent entrainment, the hydroelectric intake structure features wedge wire screens with 9.5 mm openings. National Marine Fisheries Service (NMFS) screening criteria requires screen mesh with openings no larger than 2.4 mm to prevent passage of juvenile salmonids (NMFS 2011). Although this criterion is designed for anadromous fishes, it is the only reviewed criteria for juvenile salmonids, and has been implemented in non-anadromous waters for screening juvenile salmonids. Additionally, the approach velocities near the hydroelectric intake are unknown, and blockage to any area of the screen could result in areas of increased velocity that may increase the likelihood of entrainment or impingement. Based on the current screen openings, entrainment or impingement of juvenile kokanee is possible. Surveys of the Henrys Fork Snake River immediately below Island Park Dam have documented kokanee, indicating that some size classes are able to pass though the screened intake.

The distribution of kokanee throughout Island Park Reservoir is unknown, and despite stocking over 260,000 juvenile kokanee annually since 1990, gill net and angler catch rates have remained low. Although drought, reservoir levels and other environmental conditions may have impacted kokanee since the early 1990's, the alteration of intake facilities may be inhibiting the re-establishment of the Island Park Reservoir kokanee fishery. In response to low kokanee catch rates, and to lessen the potential impacts of entrainment, IDFG altered its stocking practices in 2009. Historically, juvenile kokanee have been stocked directly into Island Park Reservoir between May and June, when inflow and outflow from the reservoir is increasing. This may contribute to the potential for entrainment as kokanee may actively follow river currents while migrating downstream (Fraley and Clancey 1988). Beginning in 2009, IDFG released half (approximately 125,000) of the annual kokanee stocking directly into Island Park Reservoir, with the remaining releases split between Big Springs Creek and Moose Creek (Figure 10). Tributary releases are intended to limit downstream migration through the reservoir and to allow kokanee to imprint on tributaries to establish spawning runs in these locations.

The objective of this study was to determine if concentrations of kokanee are present throughout the fore bay of Island Park Dam, resulting in potential losses through entrainment.

STUDY AREA

Island Park Reservoir (IPR) is located on the Henrys Fork of the Snake River 40 km north of Ashton, Idaho and 150 km upstream from the confluence with the South Fork of the Snake River (Figure 10). Island Park Dam is a 23 m high earth-fill rock-faced structure operated by the United States Bureau of Reclamation to provide water for irrigation in Fremont and Madison Counties. The drainage area upstream from the dam is 774 square km, varying in elevation from 1,920 to 3,017 meters. At gross pool capacity (143,430 acre feet), the reservoir covers 3,388 hectares and has a shoreline of about 97 km. Since first filling in 1939, the minimum storage was 270 acre-feet, occurring in 1992. Runoff and numerous springs supply water to streams entering the reservoir. Maximum storage generally occurs in May and June. Thereafter, gradual drawdown through the summer and fall lowers the reservoir to varying degrees, depending upon irrigation needs. Ice generally covers the reservoir from December to May.

METHODS

We used a boat-mounted Lowrance (LMS-527) depth finder to measure lake depth and a YSI 550-A multi-meter to measure temperature throughout the water column near the dam to determine if a thermocline existed and locate potential gill netting areas. Depths and temperatures were measured on July 26 and on August 16, immediately prior to setting gill nets. We used experimental curtain gill nets, measuring 54.9 m long by 6.1 m deep and composed of panels of 19, 25, 32, 38, 51, and 64 mm bar mesh monofilament to sample kokanee distribution near the fore bay and outlet facilities of Island Park Dam (Figure 11). Six nets were set on August 16 and four nets set on August 17 for a total of 10 net nights. Five nets were set floating on the surface and fished the top 6 m of the water column, while five nets were set at the lake bottom to fish the bottom 6 m of the water column. All fish captured were counted, and all kokanee and rainbow trout were measured for total length to the nearest millimeter. Additionally, to compare curtain gill net catch rates (catch per unit effort [CPUE]) to previous sampling, which used standard IDFG experimental gill nets, we divided curtain gill net catch by 4.1 to standardize catch rates based on total net area. Standard IDFG experimental gill nets measure 45.7 m long and 1.8 m deep (82.3 m^2), while curtain gill nets used in 2010 measured 54.9 m x 6.1 m (334.9 m^2). To further assess depth distribution of kokanee, we recorded kokanee capture location within the net curtain (top half vs. bottom half).

Additionally, we used linear regression to assess the relationship between reservoir carryover and kokanee gill net catch data from 1960 to 2010. We used the minimum pool levels from the year prior to gill net sampling and considered the relationship significant at P <0.05

RESULTS

We observed a maximum depth of 16.5 meters in front of Island Park Dam and measured temperatures between 15.8°C at 16 m deep, up to 21.0°C at the surface (Figure 12). We collected 2,489 fish in 10 net nights of effort, including 195 kokanee (CPUE: 19.5 kokanee/net night) (Table 9). Kokanee ranged from 84 mm to 520 mm, with mean and median total lengths of 181 and 122 mm, respectively (Figure 13), while rainbow trout ranged from 81 mm to 458 mm, with mean and median total lengths of 189 and 95 mm, respectively (Figure 14). Floating nets captured 36 kokanee (CPUE: 7.2 fish/net night) while sinking nets captured 159 kokanee (CPUE: 31.8 fish /net night). Overall, 82% of all kokanee captured were caught in sinking nets, while 18% of kokanee were captured in floating nets. Distribution of kokanee in floating nets was evenly distributed, with 48% captured in the upper half of the net and 52% in the lower half. In sinking nets, distribution was skewed towards the bottom, as 71% were captured in the lower half of the net, while 29% were captured in the upper half (Figure 15).

We standardized curtain gill net catch rates to compare to previous netting surveys which used standard IDFG experimental nets. Standardized curtain gill net catch rate of kokanee and rainbow trout was 4.8 and 0.9 fish per net night, respectively (Figure 16). We found no significant relationship between reservoir carryover and gill net catch rate of kokanee ($r^2 = 0.008$, $p = 0.615$; Figure 17).

DISCUSSION

Gill net surveys since 1990 have consistently shown low catch rates of kokanee, despite average annual stockings of nearly 250,000 juvenile kokanee (Appendix A). Concurrently, kokanee growth has been exceptional, with mean relative weights in excess of 110% and individuals observed greater than 500 mm (Schoby et al. 2010, Garren et al. 2008, Garren et al. 2006). Combined, these characteristics suggest density dependent growth in the kokanee population, with low survival of stocked fish and fast growth of the fish that do survive. Similar density-dependent growth in other Idaho kokanee populations has been documented (Rieman and Myers 1990). Initially, we believed kokanee survival in Island Park Reservoir was related to reservoir carryover, similar to rainbow trout (Garren et al 2008). Further examination of gill net catch data and fall reservoir levels does not support this, and indicates that other factors are likely limiting the kokanee population in Island Park Reservoir.

The gill net catch rate of kokanee near Island Park Dam in 2010 was the third highest catch rate of gill net surveys dating back to 1990. We acknowledge that our netting locations were not random, and targeted a specific problem we were trying to address. Had we implemented random sampling, we may have found similar high catch rates, or conversely, could have decreased average net catch. The non-random nature of our sampling should be considered when interpreting the results of our gill net surveys, particularly when comparing to prior years when a more random survey was implemented. Additionally, increased catch rates of kokanee may be the result of changes to the stocking locations, initiated in 2009. Beginning in 2009 and continuing to date, half of the juvenile kokanee were released in Moose Creek and Big Springs Creek with the intention of establishing a homing instinct in kokanee and keeping kokanee away from the intake screens on the dam thereby reducing or eliminating entrainment. Evaluation of this strategy will occur in the near future. However, current efforts clearly documented juvenile kokanee residing in the deepest portion of the reservoir near the dam, and in the immediate vicinity of the intake screens where entrainment is possible. While the reason for the increased catch rate of kokanee may be unclear, ultimately we documented kokanee at relatively high densities, compared to previous netting efforts, in areas where entrainment is possible.

The depth distribution of kokanee, particularly juveniles (80-160 mm), captured in gill nets indicates their proximity to the hydropower intake structure. The proximity of juvenile kokanee to the intake structure, the unknown approach velocities and screen design and spacing that will allow juvenile salmonid entrainment, suggests that kokanee entrainment may be a contributing factor limiting abundance. Beginning in 1994, the majority of water released from Island Park Dam is passed through the hydropower plant intake structure, which is located nearer to the historic river channel than the original dam intake. The proximity of the hydropower intake to the river channel may increase the likelihood of entrainment of juvenile kokanee that are either migrating downstream or utilizing deep water habitat in the fore bay of Island Park

Dam. Future research should determine the best possible methods to assess and quantify entrainment of kokanee in Island Park Reservoir.

MANAGEMENT RECOMMENDATIONS

1. Assess potential methods for quantifying entrainment of kokanee.

2. Implement annual gill net monitoring to evaluate the effects of tributary stocking to the overall kokanee population in Island Park Reservoir.

3. Establish kokanee spawning transects in Moose Creek and Big Springs Creek to monitor trends in adult abundance and determine if juvenile releases in these locations has established spawning runs.

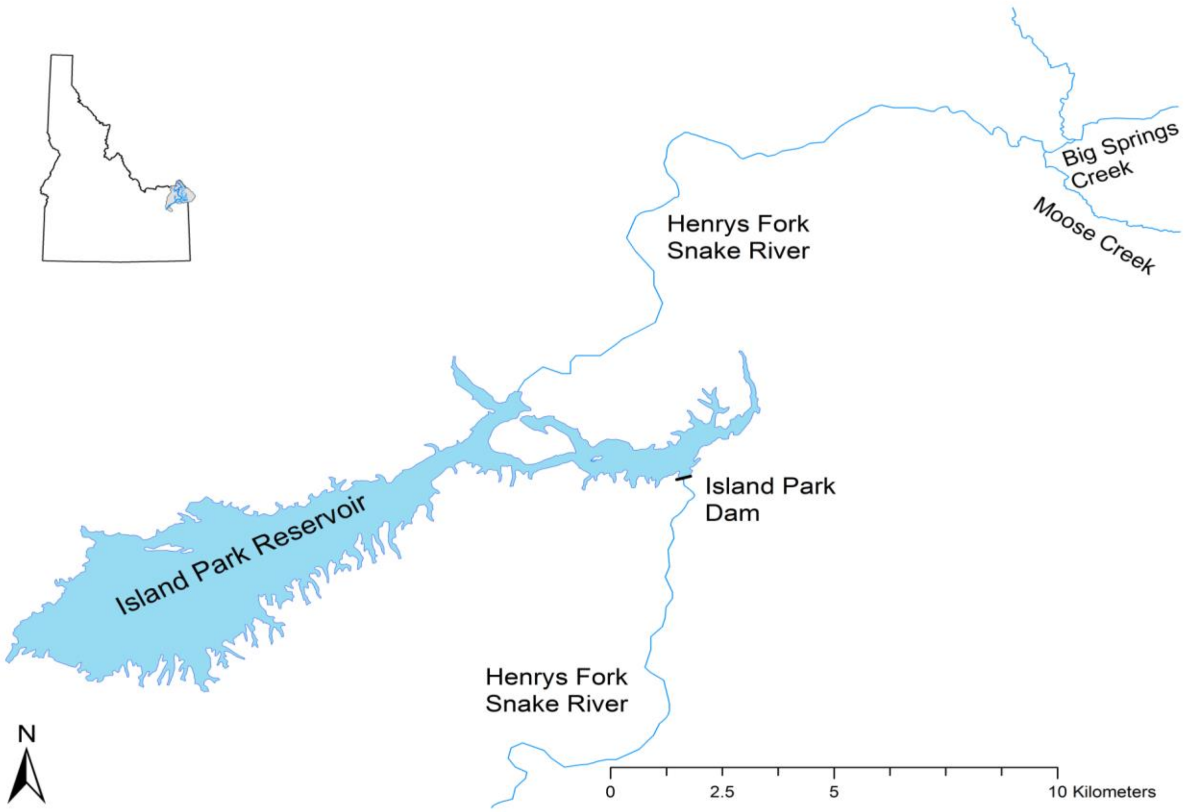

Figure 10. Island Park Reservoir, Idaho.

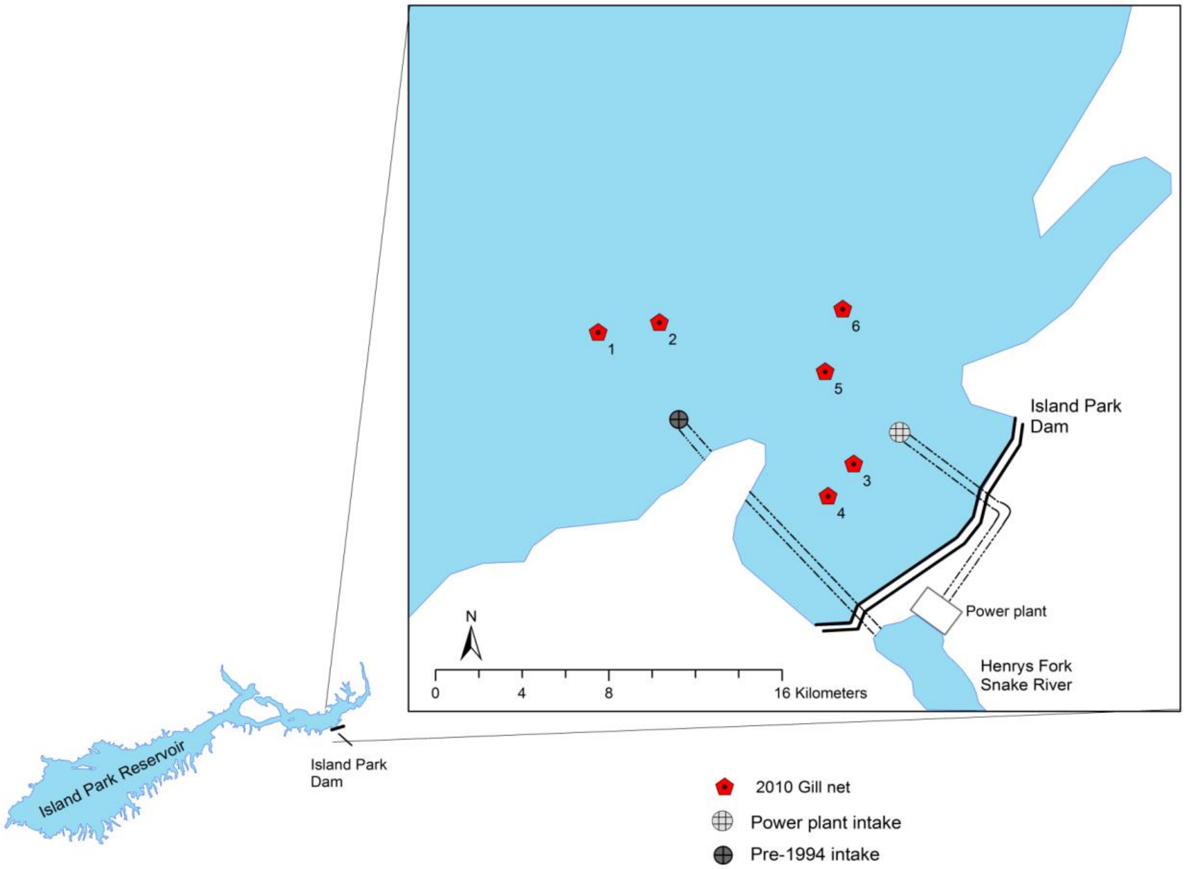

Figure 11. Gill net locations to sample kokanee distribution in the fore bay of Island Park Dam, 2010.

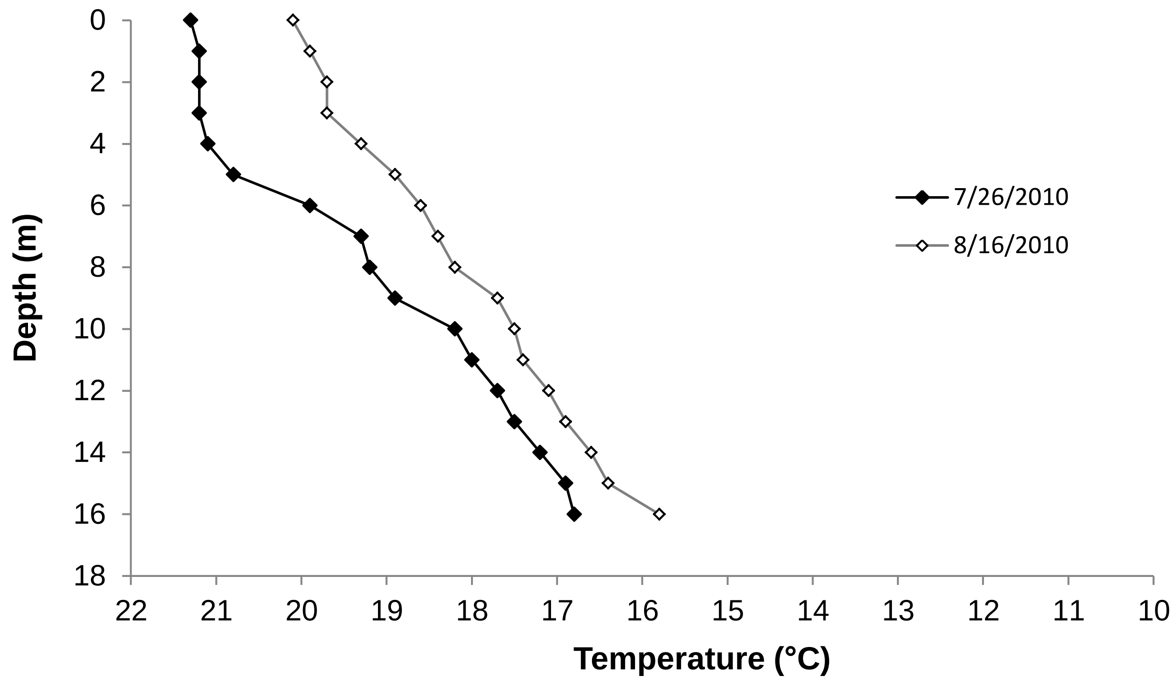

Figure 12. Temperature profiles from Island Park Reservoir, near Island Park Dam, during 2010.

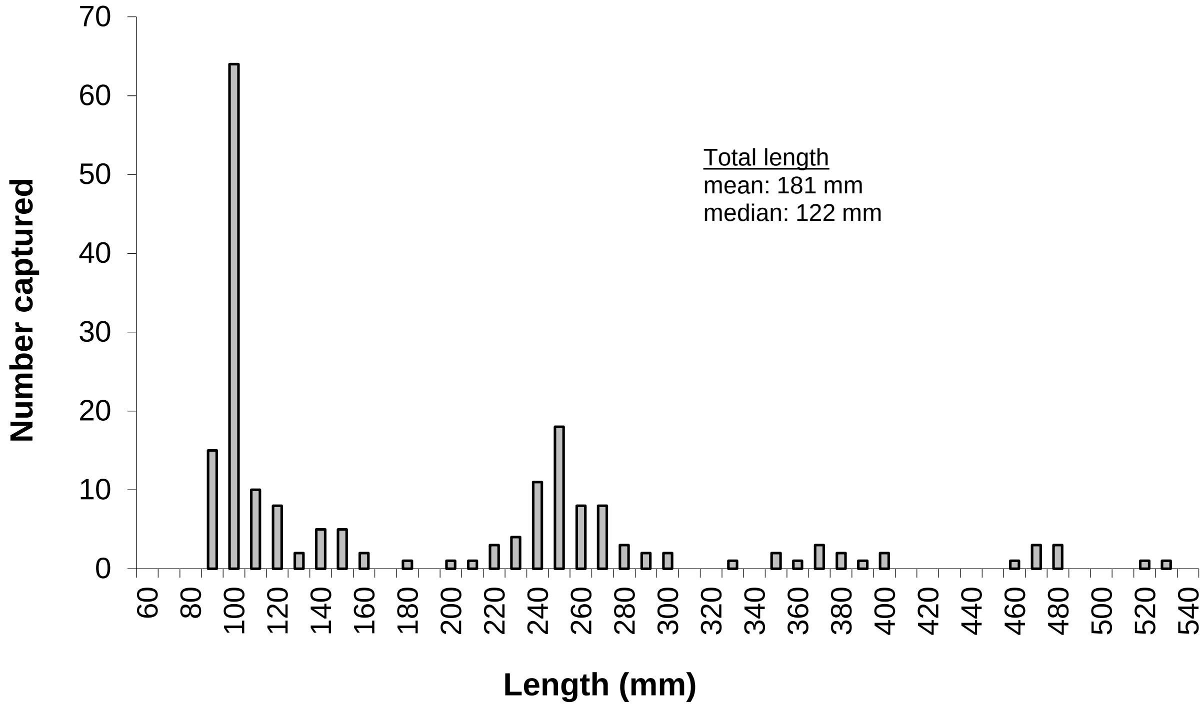

Figure 13. Length frequency of kokanee captured in Island Park Reservoir, 2010.

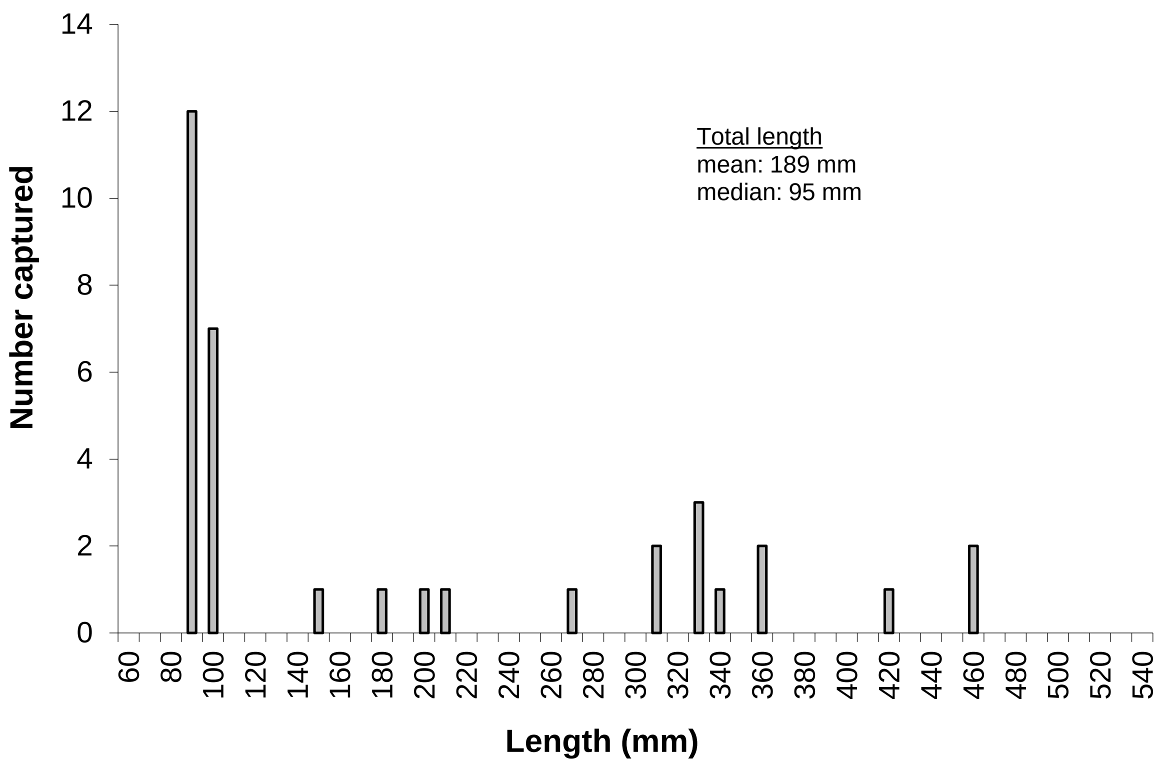

Figure 14. Length frequency of rainbow trout captured in Island Park Reservoir, 2010.

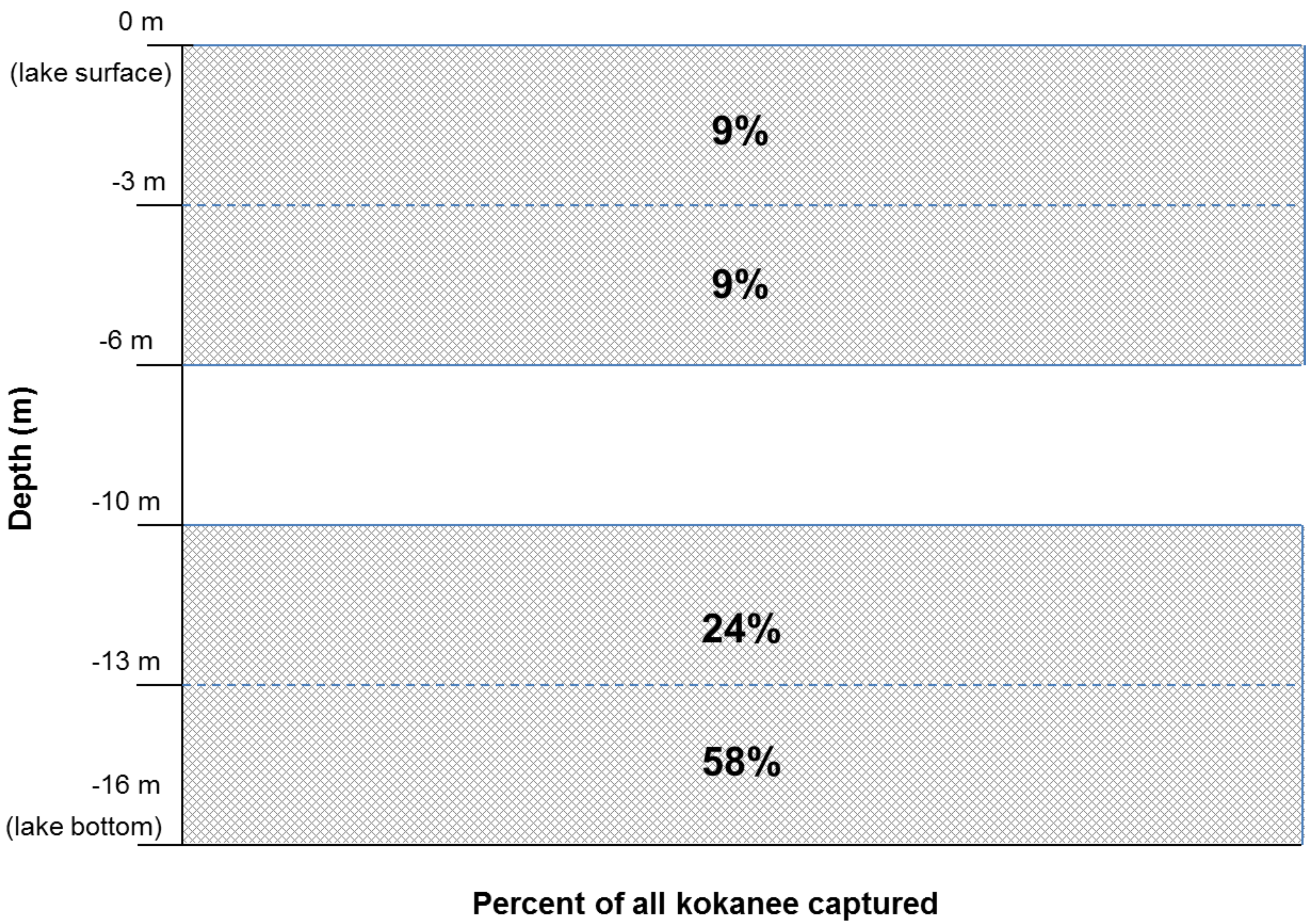

Figure 15. Depth distribution (by percentage) of all kokanee captured in curtain gill nets in 10 net nights of effort in Island Park Reservoir, in 2010.

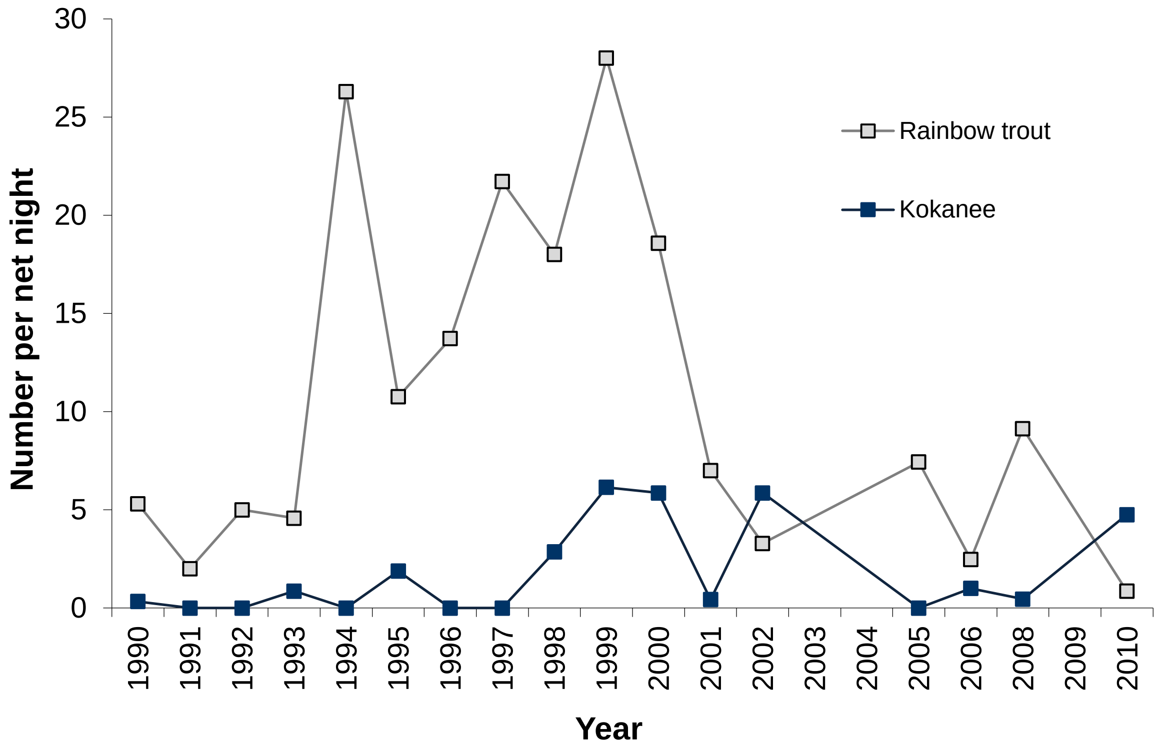

Figure 16. Gill net catch rate (fish per net night) of kokanee and rainbow trout in Island Park Reservoir, from 1990 to 2010.

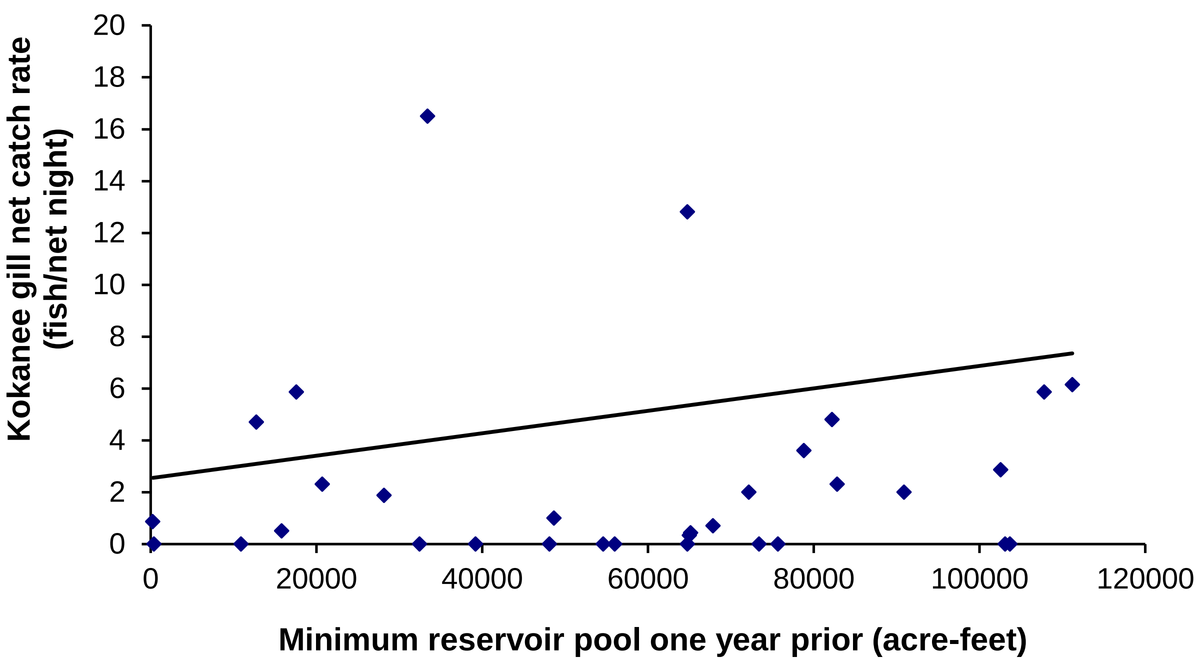

Figure 17. The relationship between kokanee gill net catch rate and minimum reservoir levels one year prior to netting, in Island Park Reservoir, 1960 – 2010 (r^2 = 0.008, p = 0.615).

Table 9. Curtain gill net catch statistics from Island Park Reservoir, 2010.

Net #	Date	Net Type	Rainbow trout	Kokanee	Utah chub	Utah sucker	Redside shiner
1a	8/16	Sink	3	41	205	31	17
1b	8/17	Sink	4	67	175	29	1
2a	8/16	Float	1	13	107	1	135
2b	8/17	Float	1	18	71	0	51
3	8/16	Float	1	2	1	33	0
4	8/16	Sink	0	3	2	90	0
5a	8/16	Float	3	2	4	142	0
5b	8/17	Sink	4	38	357	14	46
6a	8/16	Sink	16	10	582	19	100
6b	8/17	Float	2	1	0	46	0
		CPUE	3.5	19.5	150.4	40.5	35.0
		Percent of total catch	1.4	7.8	60.4	16.3	14.1

RIRIE RESERVOIR

ABSTRACT

The discovery of walleye *Sander vitreus* in Ririe Reservoir during 2008 prompted telemetry research from 2009 through 2010 to determine habitat use, spawning locations and timing as well as seasonal movements. Between mid-April and mid-May of 2009 and 2010, we used trap nets and electrofishing to capture walleye for transmitter implantation. In both years, concentrations of mature walleye were observed in or near the mouth of Willow Creek, with migrations seen as far as 2.5 km upstream of the reservoir. Based on the results of two years of telemetry research, Willow Creek appears to be the primary spawning location of walleye in Ririe Reservoir, although the possibility of other spawning locations should not be discounted. Tagged walleye moved throughout the middle reaches of the reservoir during the summer, and prior to ice formation were found approximately 4 km above the dam, near the power line crossing.

During 2010, we implemented annual fall walleye index netting (FWIN) to monitor the status of the walleye population and changes to the existing fishery in Ririe Reservoir. As expected, the current walleye population is low, and zero walleye were captured in 18 net nights of effort. Data obtained from other species collected during FWIN surveys will be used to monitor future changes in these populations.

Also in 2010, we estimated angler use, catch rates, and harvest information from Ririe Reservoir, from mid-January to mid-March for the ice fishery, and again from May until November during the open water fishery. Angler effort (68,364 hours) and total fish harvested (20,951) were the highest observed in the past four creel surveys, dating back to 1993. Overall, catch rates have declined from the early and mid-2000's, particularly Yellowstone cutthroat trout *Oncorhynchus clarkii bouvieri* and smallmouth bass *Micropterus dolomieu* catch rates, but kokanee salmon *O. nerka* and yellow perch *Perca flavescens* catch rates were similar or greater than previously seen. Ice fishing on Ririe Reservoir continued to provide a popular fishery, comprising 30% of the annual effort over the 2 month ice fishery.

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INTRODUCTION

Ririe Reservoir is located on Willow Creek, approximately 32 km east of Idaho Falls (Figure 18). Ririe Dam was constructed in 1977, with the reservoir being filled to capacity for the first time in 1978. Ririe Reservoir is fed by approximately 153 km of streams in the Willow Creek drainage, and has a total storage capacity of 100,541 acre-feet. Ririe Reservoir is approximately 17 km long, and is less than 1.5 km wide with a surface area of approximately 631 ha and mean depth of 19.5 m. Ririe Reservoir is managed primarily for flood control and irrigation (BOR 2001).

Ririe Reservoir supports a popular fishery for kokanee salmon *Oncorhynchus nerka,* Yellowstone cutthroat trout *O. clarkii bouvieri,* smallmouth bass *Micropterus dolomieu*, and yellow perch *Perca flavescens*. In 2005, angler use was approximately 43,800 hours with a catch rate of 0.9 fish per hour (Garren et al. 2006). This fishery is supported primarily through hatchery releases of Yellowstone cutthroat trout and kokanee salmon and self-sustaining populations of smallmouth bass and yellow perch. In 2001 the trout stocking program was shifted from triploid rainbow trout to Yellowstone cutthroat trout. A preliminary evaluation of return-to-creel has indicated the program has successfully replaced the rainbow trout fishery. Kokanee have been stocked since 1990 and the stocking rate was increased in 2002 to improve catch rates. This has been effective, as kokanee catch rates improved from 0.04 fish/hour in 1993 to 0.35 fish/hour in 2005. Much of this is due to an increasingly popular ice fishery. Twenty-five percent of the effort in 2005 was during the ice fishery, which was non-existent in 1993. Occasional catches of rainbow trout and brown trout *Salmo trutta* also occurred, but stocking of these species has been discontinued. In an effort to reduce Utah chub *Gila atraria* and Utah sucker *Catostomus ardens* numbers, splake (lake trout *Salvelinus namaycush* x brook trout) were stocked in Ririe Reservoir from 1996 through 1999. Impacts to chub and sucker population were not realized, and splake provided little to the recreational fishery, therefore stocking was discontinued. Anglers, however, have harvested two state record splake in recent years (2004 and 2006), demonstrating the program was successful in producing fish in excess of ten pounds over time.

Smallmouth bass were introduced into Ririe Reservoir from 1984 to 1986. A self-sustaining population has developed from the original introductions. The smallmouth bass fishery in Ririe Reservoir is limited by the short growing season at this latitude and altitude. Smallmouth bass growth does not approach growth rates in lower elevation, western Idaho impoundments. Because of the limited growth potential in the reservoir, smallmouth bass do not achieve proportional stock densities above 20 to 30 (Dillon 1992). The yellow perch fishery has fluctuated in Ririe Reservoir, largely due to water level drawdowns and the loss of inundated littoral areas. With increased reservoir levels, particularly when the reservoir fills early in the spring, the yellow perch population has increased (Schoby et al. 2010).

Walleye *Sander vitreus* were first documented in Ririe Reservoir in 2008 by an IDFG research crew (Nampa Research) examining kokanee age and growth. This prompted further investigations by Region 6 fisheries personnel. Initial gill net efforts did not yield any additional walleye. Angler reports (including capture location) of walleye led to additional monitoring by fisheries personnel, upon which four walleye were captured in gill nets near Deer Creek in the Willow Creek arm of Ririe Reservoir on July 25, 2008. Press releases were issued, encouraging anglers to harvest all walleye captured in Ririe Reservoir. Fall gill netting efforts resulted in one additional walleye captured. Although the size of the walleye population in Ririe Reservoir appears to be low based on gill net captures, there is potential for expansion. The source, timing, and number of walleye introduced into Ririe Reservoir is unknown, but two age classes (age 2 and 4) were identified in 2008 and both are assumed to be sexually mature. The impact walleye may have on the existing fishery is unclear, but in Lake Roosevelt, Washington predation by introduced walleye accounted for a 31 - 39% loss of stocked kokanee (Baldwin and Polacek 2002). Not only do walleye have the potential to impact Ririe Reservoir, but also may have the ability to spread to other waters, including the Snake River. Washington Department of Fish and Wildlife personnel have documented the spread of walleye from Banks Lake to a series of other reservoirs through irrigation canals. Additionally, in a study conducted to assess the potential for walleye introductions in Idaho (IDFG 1982), Ririe Reservoir was identified as having the biological suitability to sustain a healthy walleye population, but conflicts with maintaining the existing trout fishery were cited as the main reason for not introducing walleye into Ririe Reservoir.

OBJECTIVES

1. Document seasonal movement patterns and habitat use by walleye, with an emphasis on identifying spawning locations to aide in possible future control efforts.

2. Use continued fall gill netting to describe population characteristics of walleye in Ririe Reservoir as a long-term monitoring tool and to monitor changes in abundances of other species as an effect of walleye predation and/or competition.

3. Assess angler use and catch rates in Ririe Reservoir,

METHODS

Walleye Capture and Telemetry

We used trap nets and electrofishing to collect walleye for transmitter implantation to document movement and habitat use, and identify spawning locations. During 2009, we set eight trap nets in Ririe Reservoir from April 1 to June 1 (Figure 19). We attempted to capture walleye using boat-mounted electrofishing gear in littoral areas of Ririe Reservoir (near the dam, various rocky points, the Meadow Creek arm, and the Willow Creek arm, including within Willow Creek) on ten separate occasions, between April 20 and May 20, 2009 (Figure 20). To increase the number of tagged walleye in 2009, additional walleye capture was attempted using gill nets for six days in November at locations where spring-tagged walleye were concentrated (Figure 19). We used two experimental gill nets, set for 1-2 hours between checks, in an attempt to capture live walleye for transmitter implantation.

Based on capture efficiencies observed in 2009, we limited our trap netting to five nets fished from April 20 to April 30, 2010 (Figure 19). Also based on the result of our 2009 effort, we focused electrofishing within Willow Creek and near the creek mouth on four separate days (April 21-23 and 26) during 2010 (Figure 20).

To determine habitat use and spawning location of walleye, we implanted combined acoustic and radio transmitters (model CH-16-25, Lotek Wireless Inc., Newmarket, ON) using a surgical procedure similar to that described by Ross and Kleiner (1982). After surgery, walleye were held for 30 – 60 minutes to allow recovery before release. Each transmitter measured 50 mm in length, 16 mm in diameter, and weighed 24 g out of water. Battery life of each transmitter was approximately eight months. Each transmitter emitted an acoustic signal and radio signal, alternating between the two every five seconds. The acoustic signal operated at a frequency of 76.8 kHz, while the radio signal operated at 151.870 MHz. Combination acoustic/radio transmitters provided the ability for relocations in deep water environments as well as in noisier environments (i.e. streams) by using the acoustic and radio signals, respectively.

Walleye were tracked on a weekly basis during the spring, and monthly throughout the summer and fall. Paired, boat-mounted omni-directional hydrophones were used for mobile tracking events. This system utilized MAPHOST software (Lotek Wireless Inc., Newmarket, ON), which allows simultaneous decoding of multiple signals and uses stereo hydrophones to provide direction of arrival of the transmitters' acoustic signal. Once tagged fish were located, transmitter ID, date, time, latitude and longitude, general location, lake depth at fish location, and lake surface temperature were recorded. A hand-held three element Yagi antenna was also used to search for tagged walleye in lotic environments or when tags were presumed to be above the waterline.

Fall Walleye Index Netting (FWIN)

During the fall of 2010 we initiated the Fall Walleye Index Netting (FWIN) detailed by Morgan (2002) to collect baseline data to monitor trends in the walleye population in Ririe Reservoir. Based on the reservoir surface area, a sample size of 18 gill net nights was targeted. Gill nets were 61 m long x 1.8 m deep, and consist of eight panels (7.6 m long) containing 25 mm, 38 mm, 51 mm, 64 mm, 76 mm, 102 mm, 127 mm, and 152 mm stretched mesh. The reservoir was divided into three strata (North, Middle, South), with 6 nets set randomly in each stratum (Figure 21). FWIN protocol recommends stratifying net sets between two depth strata (shallow: 2 - 5m; deep: 5 - 15 m). Steep shoreline topography limits the amount of shallow water habitat in Ririe Reservoir; therefore we set a combination of floating and sinking gill nets over a variety of depths (Appendix B).

Aside from data collected from walleye as described by Morgan (2002), we also collected length data from all game fish species captured, as well as a sub-sample of weights from Yellowstone cutthroat trout. We calculated relative weight (*Wr*) ($Wr = [W/Ws]*100$) of Yellowstone cutthroat trout using the standard weight equation ($\log_{10}Ws = 3.099 * \log_{10}TL - 5.099$) from Kruse and Hubert (1997). In addition to assessing walleye abundance, FWIN data will also be used to monitor the status of other game fish species and potentially document impacts related to walleye.

Creel

We conducted a stratified random creel survey on Ririe Reservoir after the formation of ice coverage on January 7 through March 20, and again starting May 25 through November 13 to estimate angler use and success. We stratified sample days into weekdays and weekend and holidays to better represent angler use. Two weekdays and two weekend/holiday days were randomly selected for each two-week period to obtain effort estimates and interview anglers. During the ice fishing season, clerks interviewed anglers returning to the Juniper boat ramp/access area to collect completed trip interviews. During the open water fishery, interview location was randomized at the two access points (Juniper and Blacktail). Effort was estimated by instantaneous angler counts from the Juniper access area during the ice fishery. During the open water fishery, effort information was obtained by counting anglers from a fixed-wing aircraft that circled the reservoir twice per week. Count times were randomly selected and started no earlier than ½ hour after sunrise, and were completed no later than ½ hour before sunset. We obtained catch and harvest information, residency information and gear type used with direct interviews. We analyzed our data using Microsoft Excel and used formulas described in McArthur (1993) to compare current and historic creel surveys. We also estimated the number of fish caught by multiplying catch rate estimates for each species by the total effort estimate.

RESULTS

Walleye Capture and Telemetry

2009

We collected 11,061 fish in 471 trap net nights of effort. Species composition was dominated by Utah sucker (45%) and yellow perch (43%), followed by Utah chub (10%) and Yellowstone cutthroat trout (2%) (Figure 22). Smallmouth bass and walleye comprised only 0.12% and 0.04% of the total catch, respectively. Trap net catch rates (fish/net night) were highest for Utah sucker (10.6) and yellow perch (10.0) (Table 10). We collected four walleye with trap nets (0.008/net night) that were then used for the telemetry study. Yellow perch (N = 4,702) ranged from 70 to 327 mm in total length (Figure 23; Table 11), with a mean total length of 195 mm. We collected weights from 694 yellow perch ranging from 70 to 312 mm total length (mean = 193 mm). Mean relative weight for yellow perch was 98. Yellowstone cutthroat trout (N = 256) ranged from 231 to 490 mm (Figure 24; Table 11), with a mean total length of 338 mm. Smallmouth bass (N = 13) ranged from 242 to 386 mm, with a mean total length of 315 mm. Walleye (N = 4) ranged from 439 to 500 mm, with a mean total length of 457 mm.

We collected 16 walleye by electrofishing throughout the lower 2 miles of Willow Creek and along shoreline areas of Ririe Reservoir near the mouth of Willow Creek in 6.5 hours of electrofishing. An additional 3.6 hours of electrofishing within the Meadow Creek arm of Ririe Reservoir and along Ririe Dam did not produce any walleye. Overall, walleye electrofishing CPUE was 1.6 fish per hour of electrofishing; while electrofishing only within Willow Cr, CPUE was 2.5 fish per hour.

We implanted 20 walleye (19 males, 1 female) with transmitters between April 20 and May 13, of which 16 were captured by electrofishing and 4 were captured in trap nets (Figure 8; Appendix C). Spring tagged walleye averaged 450 mm in total length (range: 402 - 511 mm) and weighed an average of 890 g (range: 545 – 1550 g) (Figure 27; Table 12). Walleye were relocated an average of 7 times each (range: 3-14) from tagging until December. Seven transmitters were recovered from walleye after returning from Willow Creek; transmitters were recovered from various locations throughout the reservoir over the course of the summer and fall. It is unknown if these walleye died or transmitters were expulsed. Six tagged walleye exhibited little movement after returning from Willow Creek to the reservoir and were deemed probable mortalities or shed transmitters but were unable to be recovered (Figure 28). Two tagged walleye were harvested by one angler in July. Additionally, one walleye tagged during the spring of 2009 was harvested by an angler on April 15, 2010. Five walleye carrying transmitters were relocated until the reservoir froze in December and tracking ceased.

Walleye implanted with transmitters in the spring of 2009 were actively migrating into the lower reaches of Willow Creek in early to mid-April. We documented movements as far as 2.5 km up Willow Creek, likely related to spawning activity (Figure 29A). Tagged walleye migrating into Willow Creek returned to the reservoir by mid-May. Walleye used various areas of the reservoir throughout the summer, but were predominantly found in the southern half of the reservoir (Figure 29B). Tagged walleye migrated towards the northern third of the reservoir during the fall, and concentrated near the power line crossing during October and November (Figure 30). All five walleye tracked throughout 2009 were found in or near Willow Creek in late April 2010. One walleye tagged in 2009 and tracked throughout the summer and fall was harvested by an angler in the Willow Creek arm on April 15, 2010.

In early November, two tagged walleye were located at the mouth of the Meadow Creek arm of the reservoir. Two experimental nets set at this location over three days failed to capture any walleye. In mid-November four tagged walleye were concentrated north of Meadow Creek near the power line crossing. Three days of two experimental gill net sets yielded three walleye. One of the three captured walleye had been previously tagged; two were unmarked fish and were implanted with transmitters. Fall tagged walleye averaged 471 mm in total length (range: 465 - 476 mm) and weighed an average of 1075 g (range: 1050 – 1100 g). Migration data from walleye tagged in the fall of 2009 are included with 2010 tagging and tracking below.

2010

We collected 5,327 fish in 51 trap net nights of effort. Species composition was dominated by yellow perch (89%), followed by Utah sucker (10%). Yellowstone cutthroat trout (0.6%), Utah chub (0.5%), smallmouth bass (0.09%) and walleye (0.02%) comprised of the rest of the catch (Figure 21). Trap net catch rates (fish/net night) were highest for yellow perch (92.5) and Utah sucker (10.7) (Table 10). We collected one walleye with trap nets (0.02/net night) that was then used for the telemetry study. We measured 3,709 of the 4,716 yellow perch captured; total length ranged from 45 to 282 mm in total length (Figure 24; Table 12), with a mean total length of 186 mm. Yellowstone cutthroat trout (N = 32) ranged from 300 to 422 mm (Figure 25; Table 12), with a mean total length of 346 mm. One walleye was captured, with a total length of 470 mm.

We collected 25 walleye by electrofishing throughout the lower mile of Willow Creek in 4.1 hours of electrofishing (CPUE: 6.2 fish/hour).

We implanted transmitters in 21 walleye (17 females, 3 males, 1 unknown) between April 21 and April 27 in or near the mouth of Willow Creek, of which 20 were captured by electrofishing and 1 by trap netting (Figure 26). Tagged walleye averaged 502 mm in total length (range: 447 - 560 mm) and weighed an average of 1,352 g (range: 775 – 2050 g) (Figure 27; Table 12). During 2010, walleye were relocated an average of 5 times each (range: 2-10) over the summer. Five walleye tagged in 2010 were never able to be relocated after tagging. It is unknown if these fish were removed from the system (i.e. harvested by anglers or predators) or if the transmitters malfunctioned. Seven transmitters were recovered from mortalities or were shed over the course of the season, at various locations throughout the reservoir after returning from Willow Creek. Four tagged walleye exhibited little movement after returning from Willow Creek to the reservoir and were deemed probable mortalities or shed tags (Figure 31). Seven walleye (5 tagged during spring 2010, and 2 tagged in fall 2009) carrying transmitters were tracked until the fall of 2010.

Walleye tagged in the spring of 2010 demonstrated movements similar to those observed in 2009. Four walleye tagged during the spring of 2009 along with the two walleye tagged in fall 2009 were observed in or near the mouth of Willow Creek in April 21, 2010. Walleye captured and tagged in or near Willow Creek migrated upstream, presumably to spawn, and returned to the reservoir by mid-May. Similar to 2009, tagged walleye remained in the southern half of the reservoir (particularly the Willow Creek arm) throughout the summer, and migrated towards the northern half of the reservoir as fall progressed (Figure 32).

Fall Walleye Index Netting (FWIN)

We captured zero walleye as part of our initial FWIN monitoring. Overall, FWIN catch composition was dominated by Utah sucker (53%), followed by Utah chub (15%), yellow perch (12%), Yellowstone cutthroat trout (11%), kokanee (9%), and smallmouth bass (<1%) (Figure 33). Gill net catch rate (fish per net night) was also highest for Utah sucker (42.4), followed by Utah chub (11.6), yellow perch (9.2), Yellowstone cutthroat trout (9.1), kokanee (7.3), and smallmouth bass (0.3) (Table 13). We captured 165 yellow perch during FWIN, ranging from 170 mm to 265 mm (mean: 224 mm) (Figure 34). Yellowstone cutthroat trout (n = 164), ranged from 223 mm to 534 mm (mean: 310 mm) (Figure 35), and kokanee (n = 132), ranged from 160 mm to 295 mm (mean: 186 mm) (Figure 36). Six smallmouth bass were captured, ranging from 211 mm to 388 mm (mean: 306 mm) during the FWIN monitoring.

Mean relative weight (*Wr*) from 153 Yellowstone cutthroat trout collected during the FWIN monitoring in Ririe Reservoir was 81 (Figure 37).

Creel

We interviewed 876 anglers in 384 parties over the course of the creel survey. Average party size was 2.3 anglers, and average trip length was 4.0 hours. We estimated overall season effort at 68,364 hours (Table 14). Over the entire season, residents made up the bulk of anglers interviewed (96%), and gear type was mainly split between bait (62%) and lures (38%), while few anglers fly fished on Ririe Reservoir (1%). Overall catch rate (fish caught per hour) was 0.55, with the majority of this being yellow perch (0.21) and kokanee (0.18) (Figure 38). Smallmouth bass and Yellowstone cutthroat trout catch rates were 0.12 and 0.04, respectively. Anglers caught an estimated 14,181 yellow perch, 12,459 kokanee salmon, 7,952 smallmouth bass, and 3,053 Yellowstone cutthroat trout. With the exception of smallmouth bass, the percentage of fish caught that are harvested remains high in Ririe Reservoir (Figure 39). Overall, an estimated 20,451 fish were harvested from Ririe Reservoir during 2010, with kokanee (10,618) and yellow perch (8,621) comprising over 90% of the harvest (Figure 40; Table 14).

When comparing the open water and ice fisheries of Ririe Reservoir during 2010, anglers spent 20,456 hours of effort in the ice fishery (January 7 - March 20) and 47,908 hours during the open water fishery (May 25 - November 13). Overall catch rates were higher in the open water fishery (0.91) than the ice fishery (0.38) (Table 15). During the open water fishery, catch rates were highest for yellow perch (0.49) and smallmouth bass (0.31), while kokanee salmon (0.34) provided the majority of the angler catch during the ice fishery. Catch rates of Yellowstone cutthroat trout were low in both the open water (0.04) and ice fishing season (0.02).

DISCUSSION

Telemetry results indicate that the majority of walleye spawning activity likely occurs within the lower 2 km of Willow Creek, with concentrations of walleye found in or near the mouth of Willow Creek between mid-April and mid-May. We did not observe any concentrations of tagged walleye along the reservoir shoreline to indicate that spawning may be occurring in these areas, but this may be biased since all tagged walleye were captured either in the Willow Creek arm of the reservoir or within Willow Creek itself and other spawning locations may be present. We were unable to collect walleye during the spring spawning season anywhere other than in the vicinity of Willow Creek. Future walleye removal efforts should be concentrated in this area, but success may be limited. Trap nets proved to be an inefficient method of capture for walleye in Ririe Reservoir, as evidenced by catch rates observed during both years. Walleye were present in the Willow Creek arm of the reservoir, as evidenced by electrofishing results, and are actively migrating into Willow Creek during April and May, but trap net catch rates were low. We believe that walleye migrating to Willow Creek are not following the shoreline, but are using deeper water in the Willow Creek channel, making trap net capture inefficient. Electrofishing capture was difficult due to limited visibility and increased flows during spring runoff within Willow Creek, but proved to be the most effective manner of walleye capture.

We experienced considerable tag loss and/or mortality throughout the course of the study. This may be related to the surgical procedure, spawning related stress, or a combination of both factors. Of the transmitters recovered, movement of these fish ceased from 1 to 3 months after returning to the reservoir after spawning. Of the two walleye tagged during the fall of 2009, both were found in or near the mouth of Willow Creek in mid-April, nearly 5 months after being tagged. Movement of one of these walleye stopped near the mouth of Willow Creek in mid-June. This transmitter was later recovered in September, after reservoir levels dropped, but suggests that this fish either died or shed its transmitter while spawning. While low densities limited our ability to capture and tag large numbers of walleye from other locations, future studies should consider the possibility of increased mortality from capturing and tagging walleye while they are actively spawning.

The fall of 2010 marked the initial year of fall walleye index netting and the absence of walleye in 18 net nights of effort was not entirely unexpected, as the population at this point is believed to be relatively small. Results of FWIN confirm this belief but will be useful in long-term monitoring as the status of the walleye population changes. Also, data collected from other fish species captured both game and non-game species, and should continue as this data can be used to evaluate the impacts that walleye may have on these species.

Creel survey results in 2010 indicate that the overall catch rate has declined since 2005 and 2003, but has increased compared to 1993. The biggest decline in catch rate from 2005 was seen in Yellowstone cutthroat trout. With the exception of smallmouth bass, the percentage of fish caught that are harvested remains high in Ririe Reservoir, although harvest of Yellowstone cutthroat trout has decreased from previous years. Overall number of yellow perch and kokanee salmon was the highest recorded in 2010, while harvest of Yellowstone cutthroat trout was less than 20% of that seen in 2005. Low catch rates and decreased harvest suggest that the transition to cutthroat trout stocking in 2003 has not satisfactorily replaced the rainbow trout fishery that previously existed. Further, relative weights of cutthroat trout suggest these fish are not performing as well as hoped when stocking began.

Ice angling on Ririe Reservoir continues to be an important component of the fishery, with 30 percent of the annual angling effort expended over 2 months of ice fishing in 2010. Nearly twice as many kokanee were harvested during the ice fishery than in the open water fishery. Over 10,000 kokanee were harvested over the course of the year on Ririe Reservoir, with 64% coming from the 2 month ice fishery. The kokanee catch rate was higher in the ice fishery (0.34) than the open water season (0.12), but was still below the management goal of 0.6 fish per hour. Kokanee catch rates are related to stocking rates 2 years prior, and can likely be improved with increased stocking, but average size may decrease. Also, the potential impacts of walleye on the existing kokanee fishery are unclear, and alterations to the stocking rate may cloud evaluations of impacts to kokanee from walleye.

Yellowstone cutthroat trout still provide little to the fishery within Ririe Reservoir. Return to creel is low and stocking rate shows no relationship to catch rate. Combined with low relative weights observed during FWIN sampling, future stocking of Yellowstone cutthroat trout should be reviewed and other possibilities, such as triploid rainbow trout, should be explored.

Yellow perch harvest has increased five-fold since the 2005 creel survey, indicating that increases in abundance and size has been recognized by anglers and provides another component to the fishery. Increases in yellow perch were first observed in 2008 and are likely related to spring reservoir levels. Continued water years with normal to high snow pack and increased precipitation will likely continue to benefit the perch fishery in Ririe Reservoir.

MANAGEMENT RECOMMENDATIONS

1. Continue annual walleye monitoring (fall walleye index netting [FWIN]) to gather information on abundance, growth, mortality, reproduction, and diet.

2. Evaluate potential options to limit walleye reproduction in Willow Creek.

3. Educate anglers on walleye movement patterns, concentrations, and the importance of angler harvest to help limit the possible impacts to the existing fishery.

4. Re-evaluate Yellowstone cutthroat trout stocking program and consider replacing with triploid rainbow trout.

5. Consider alterations in kokanee stocking rate to help meet management goals.

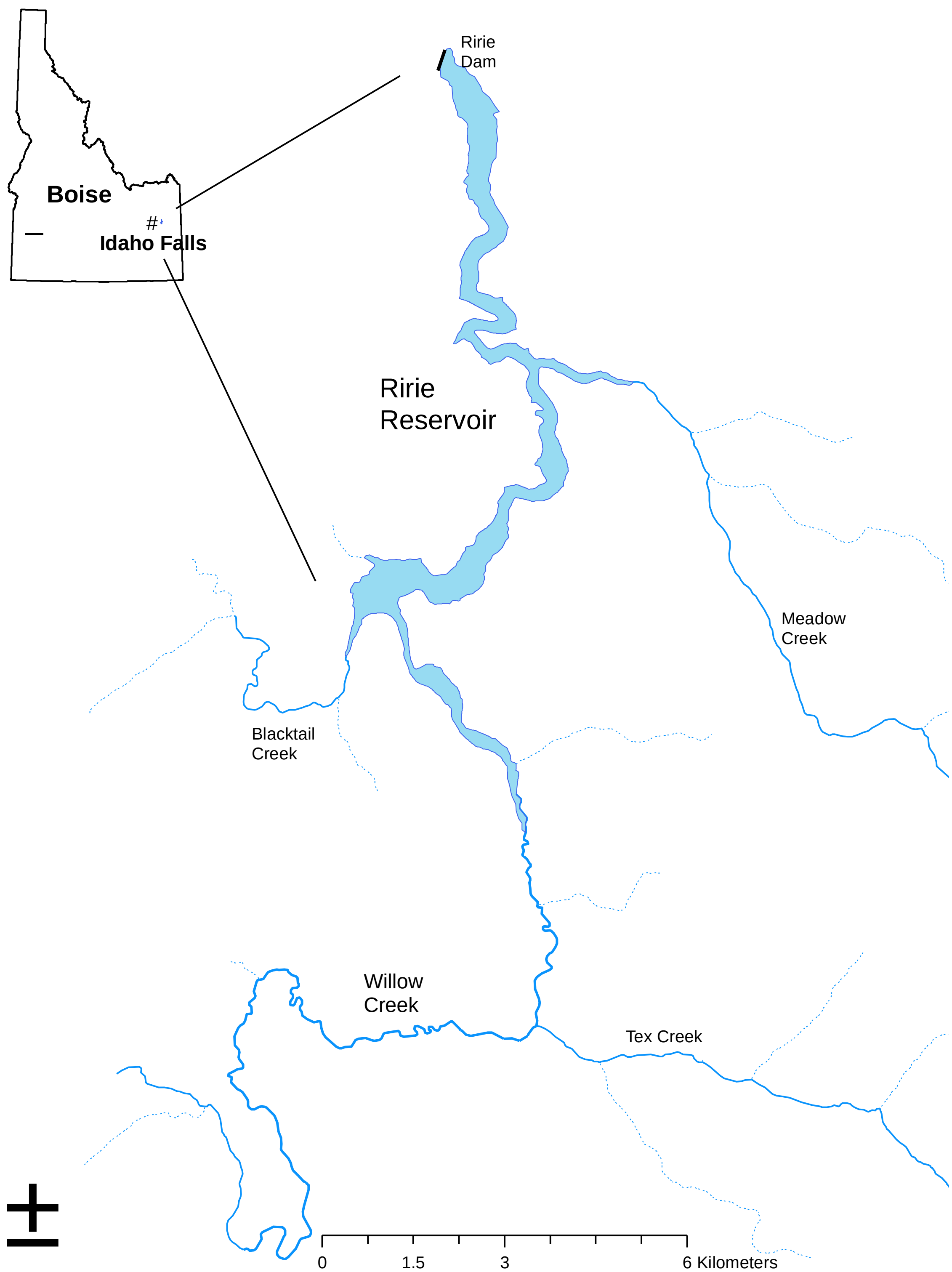


Figure 19. Location of Ririe Reservoir and major tributaries.

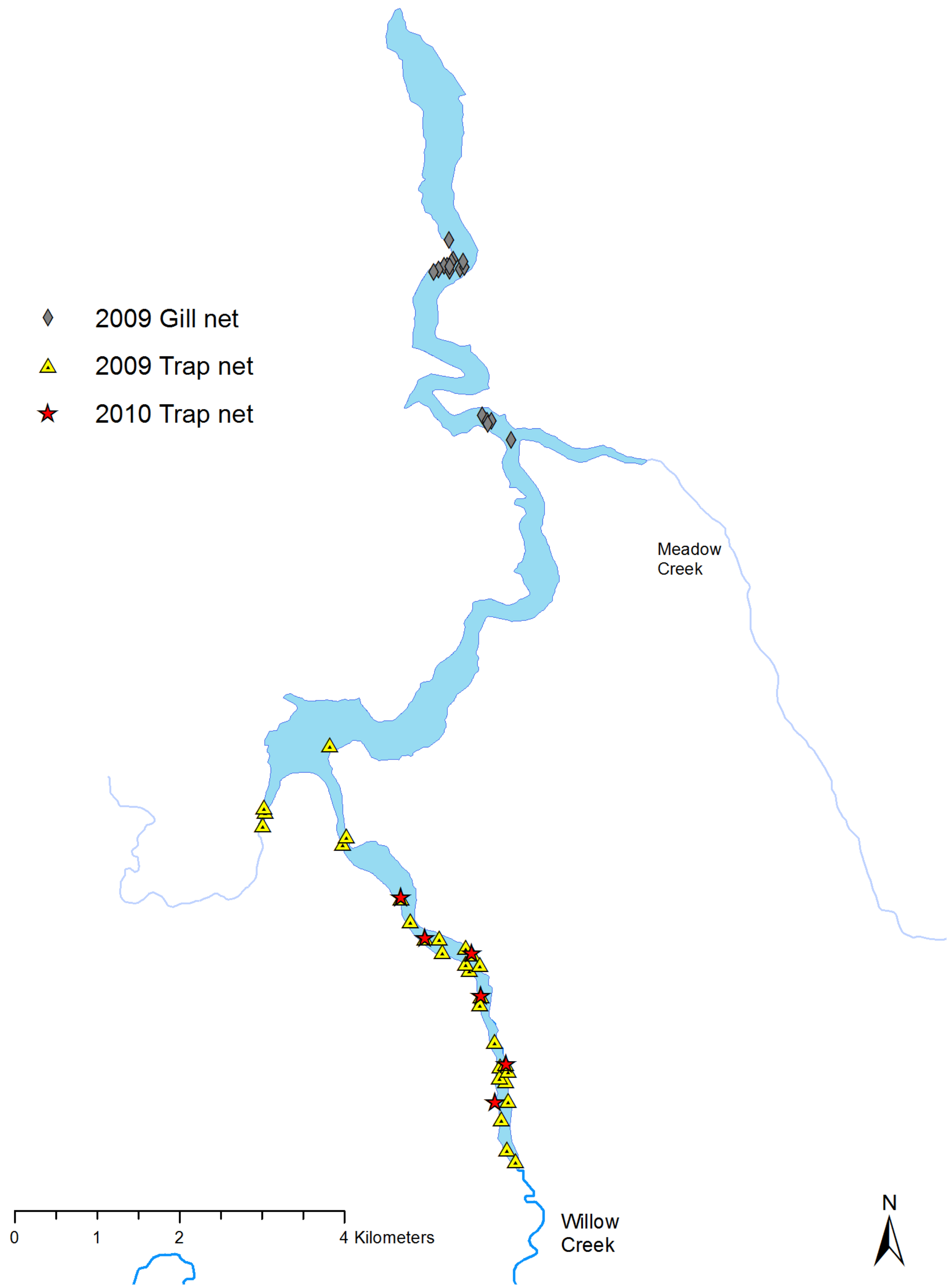


Figure 20. Locations of spring trap netting (2009 – 2010) and fall gill netting (2009) for walleye capture and transmitter implantation in Ririe Reservoir.

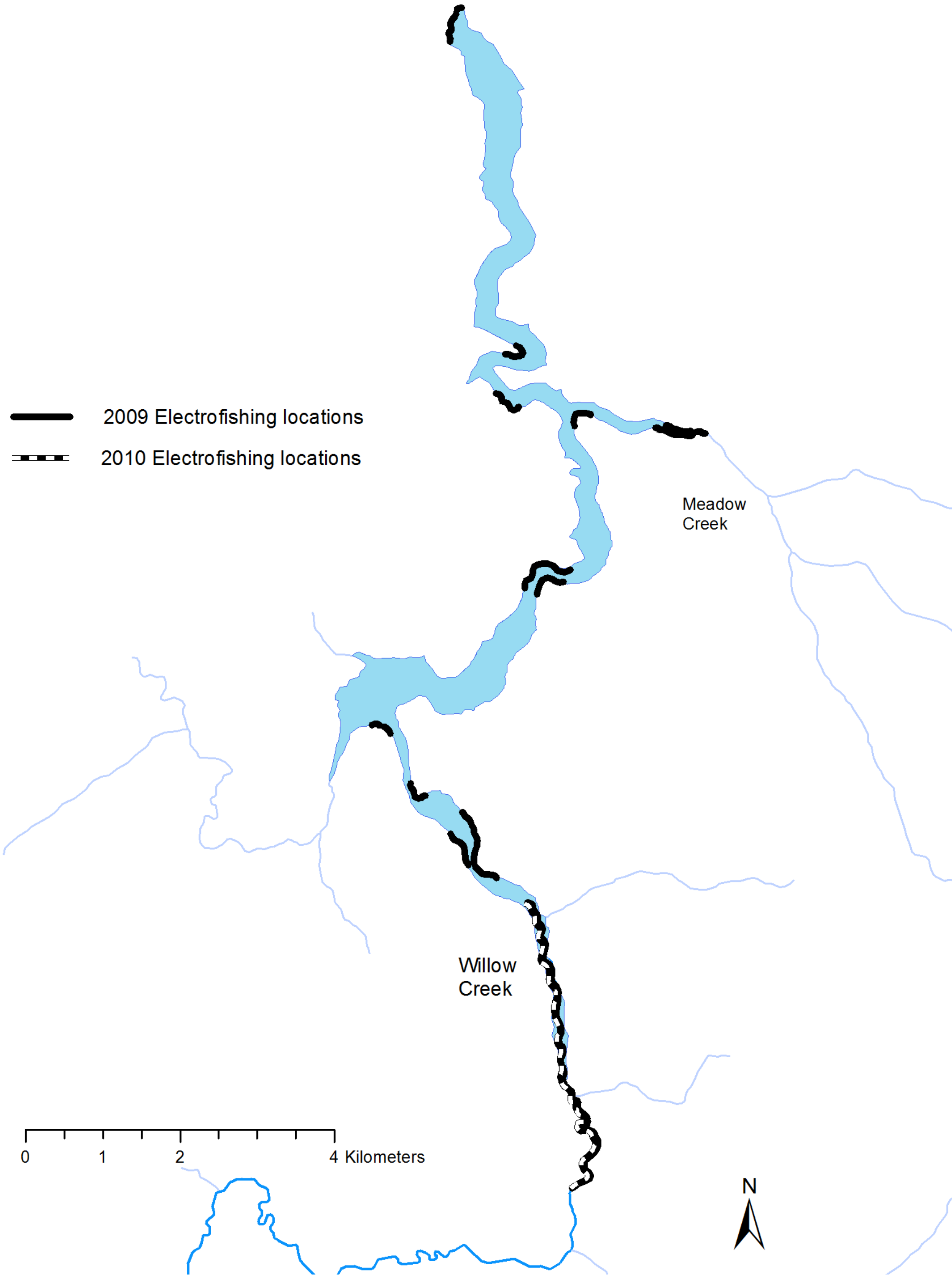


Figure 21. Locations of spring electrofishing for walleye capture and transmitter implantation in Ririe Reservoir.

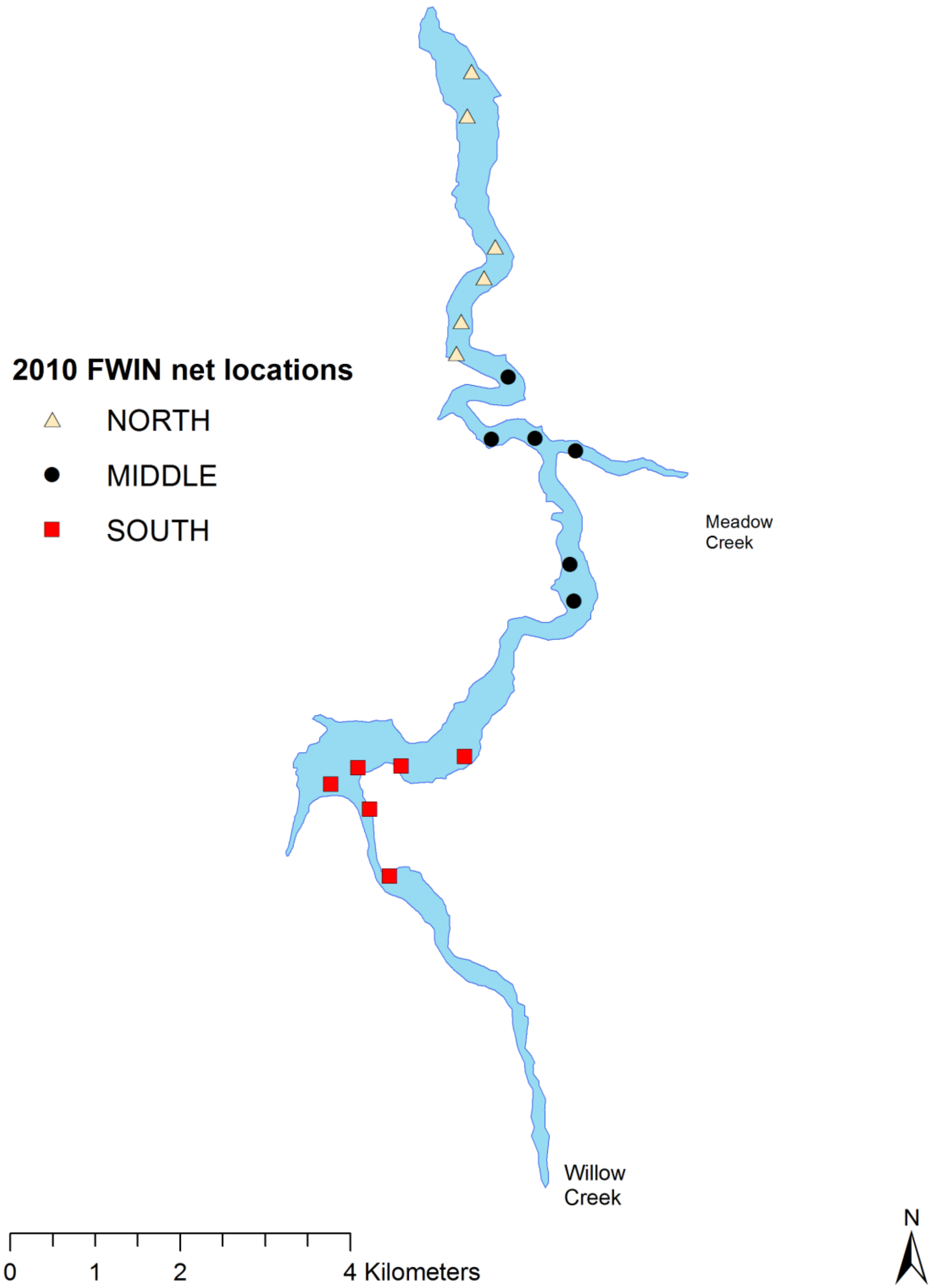
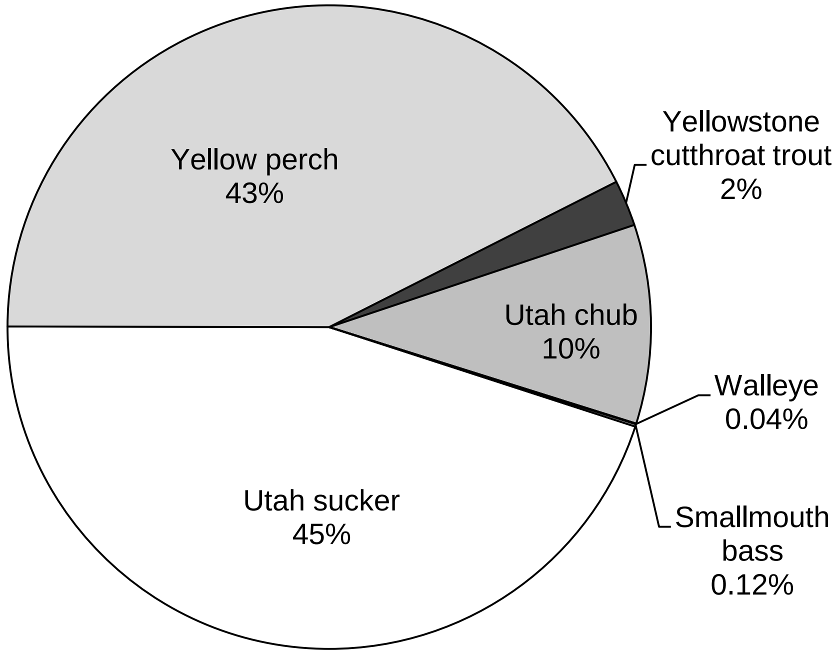


Figure 22. Locations of fall walleye index netting (FWIN), by lake strata, in Ririe Reservoir.

A.)



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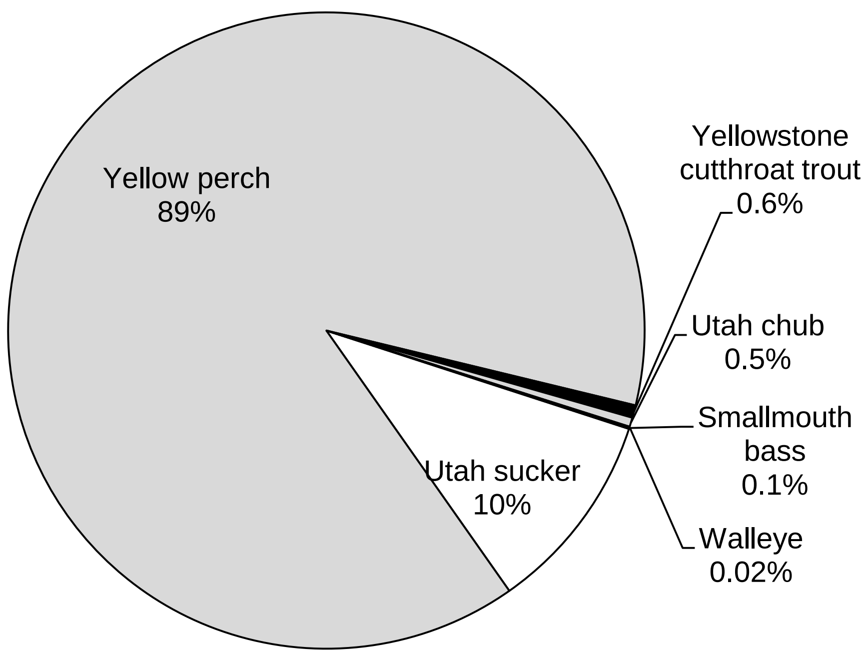


Figure 23. Species composition of fish captured in trap nets in Ririe Reservoir, from April 1 - June 1, 2009 (A) and April 20 - 30, 2010 (B).

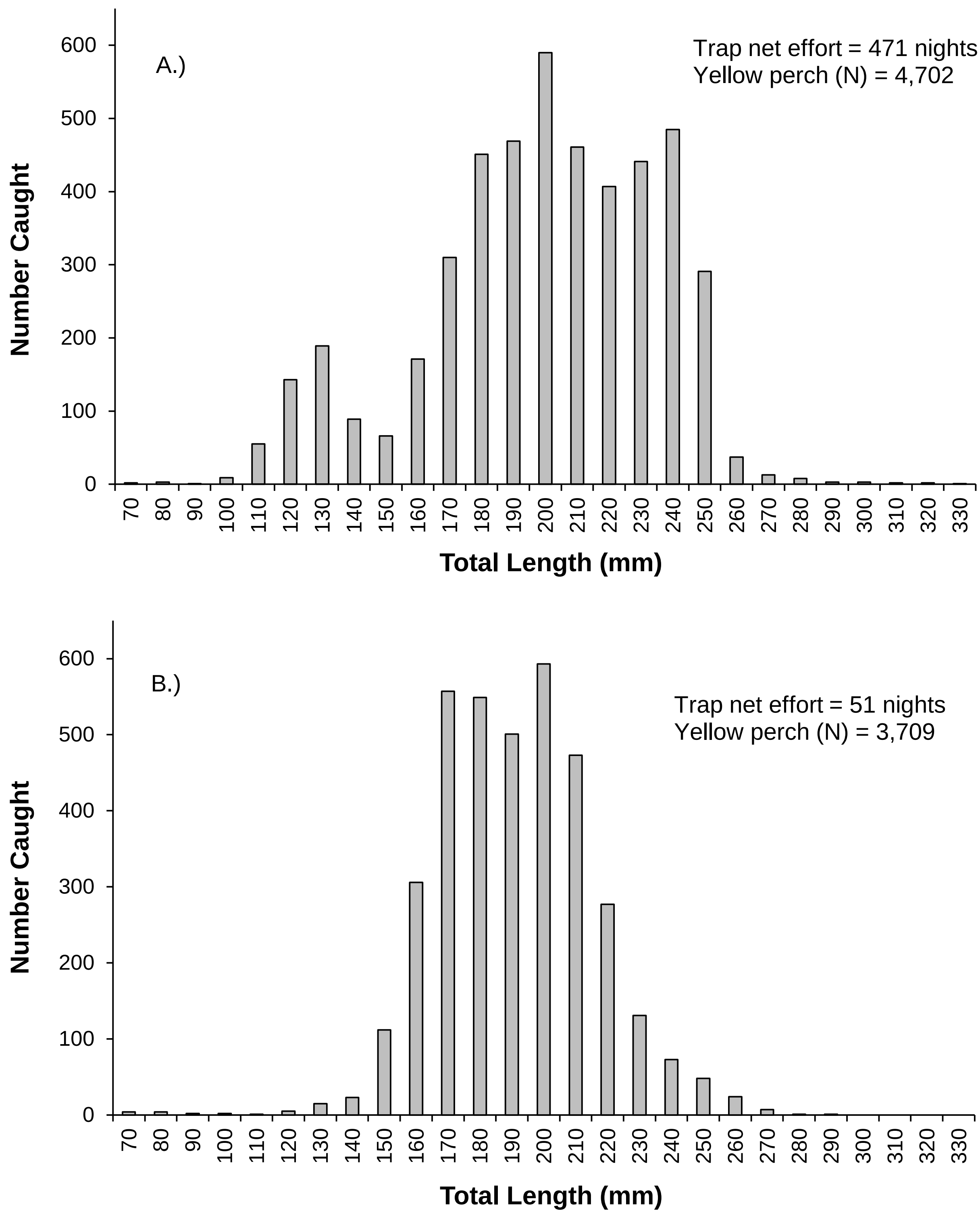
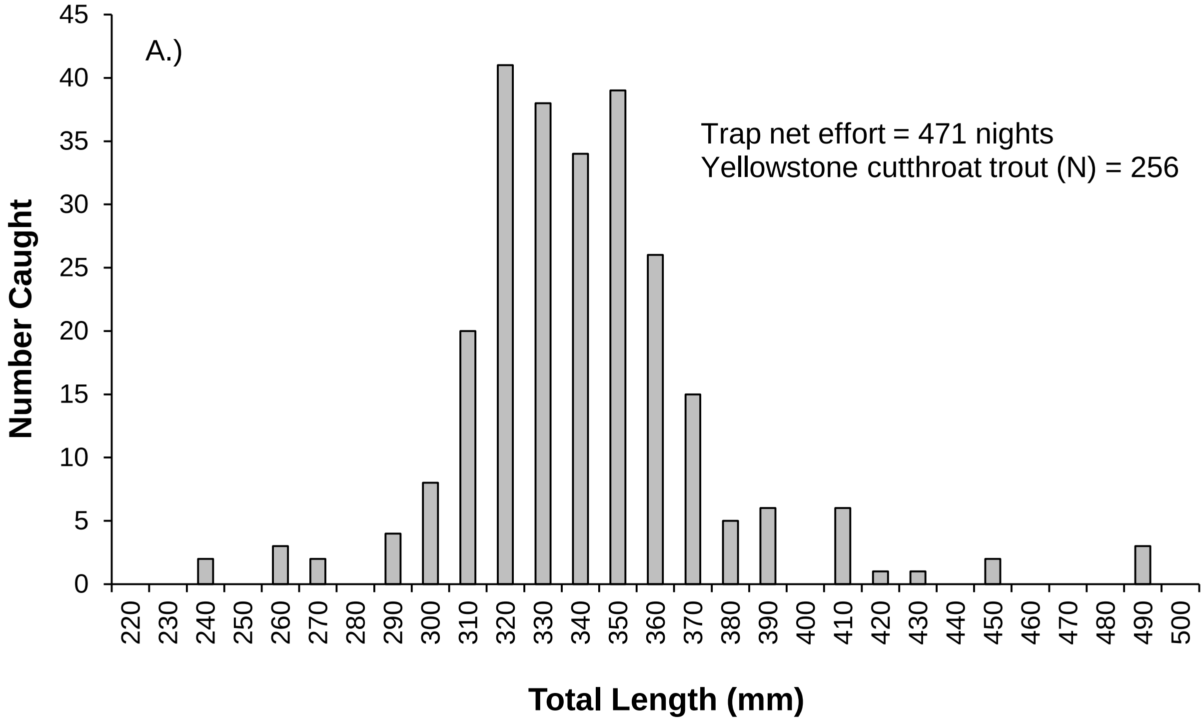


Figure 24. Length frequency of yellow perch collected in trap nets in Ririe Reservoir, from April 1 - June 1, 2009 (A) and April 20 - 30, 2010 (B).



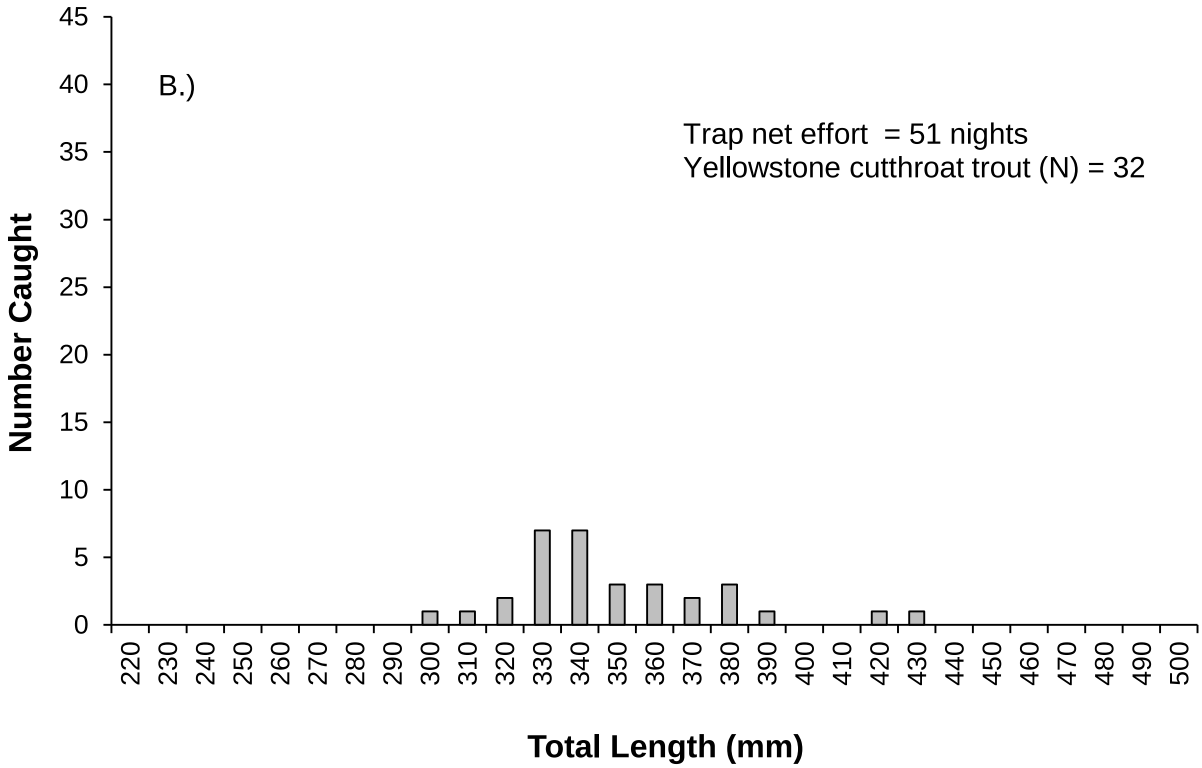


Figure 25. Length frequency of Yellowstone cutthroat trout collected in trap nets in Ririe Reservoir, from April 1 - June 1, 2009 (A) and April 20 - 30, 2010 (B).

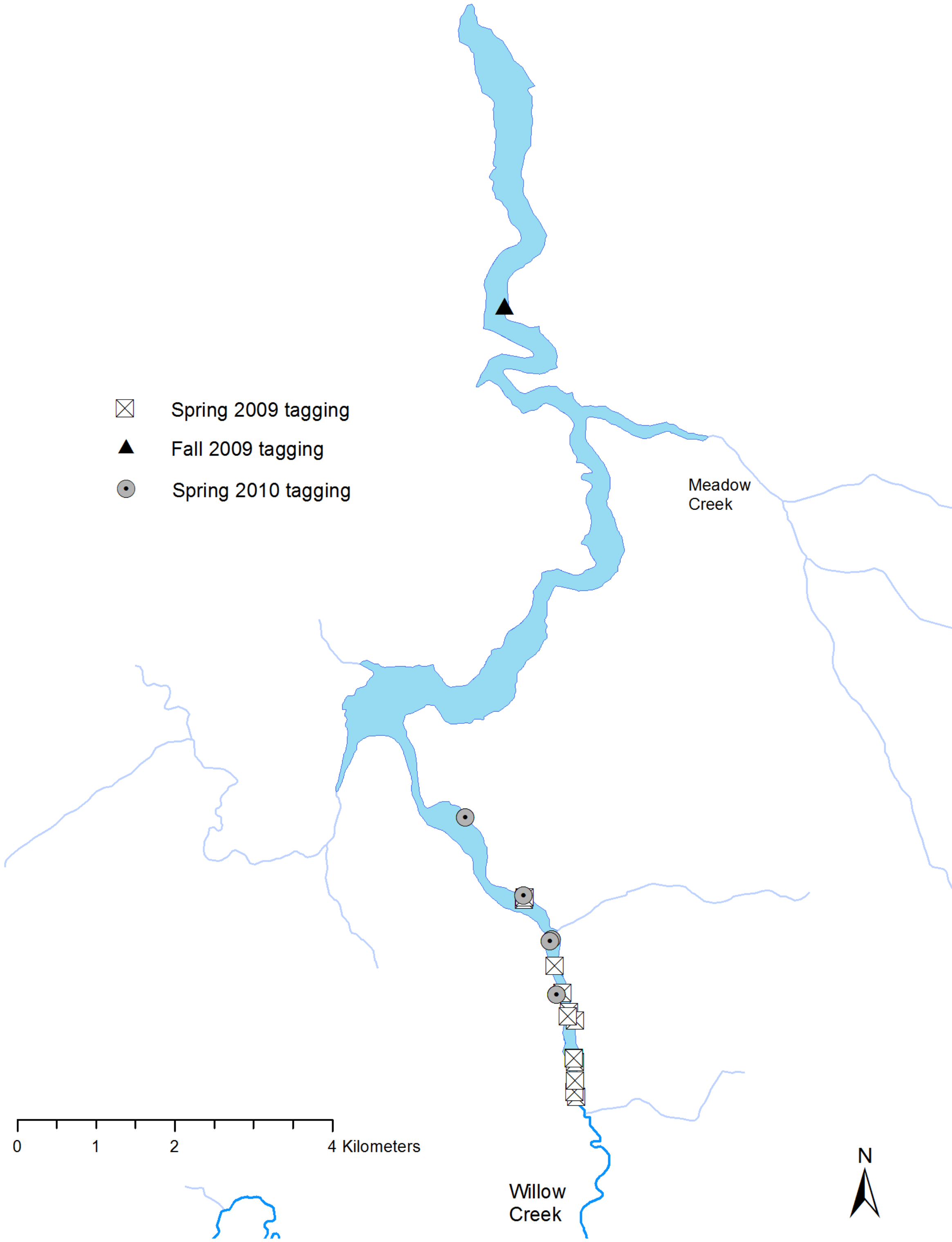


Figure 26. Tagging location of walleyes implanted with combined acoustic and radio transmitters in Ririe Reservoir, 2009 - 2010.

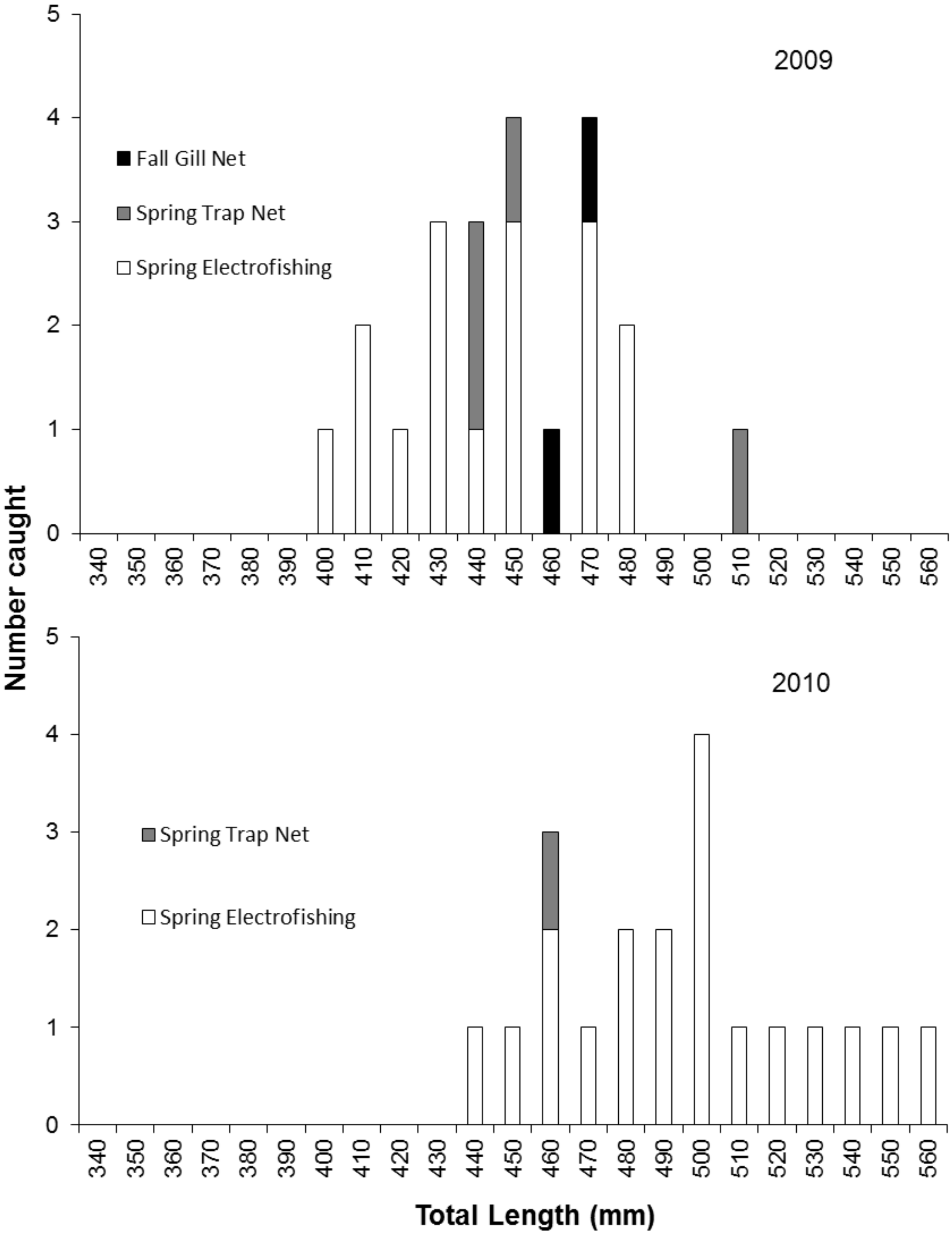


Figure 27. Length frequency of walleye implanted with combined acoustic and radio transmitters, by collection method, in Ririe Reservoir during 2009 (A) and 2010 (B).

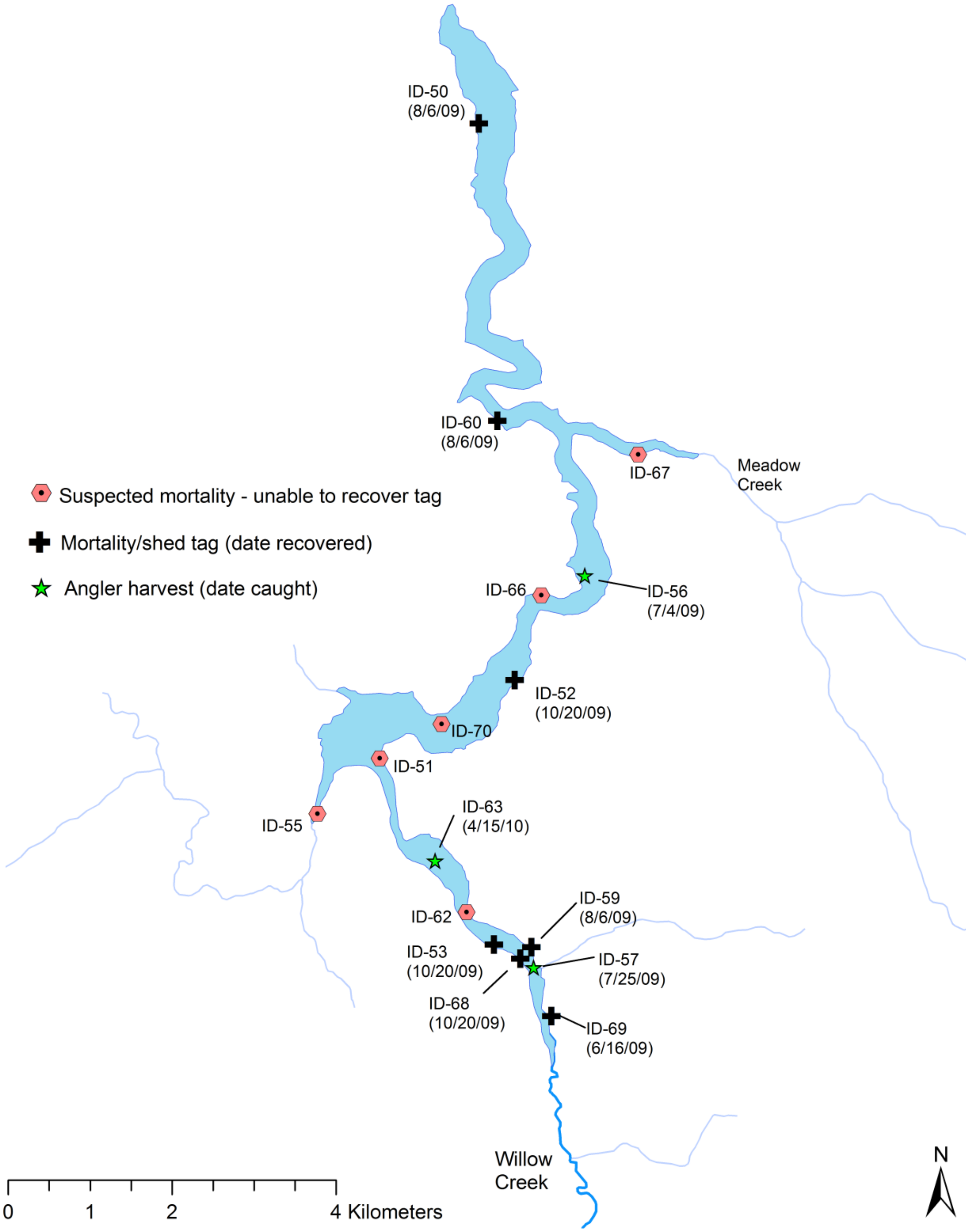


Figure 28. Suspected walleye mortalities, recovered walleye transmitters, and tagged walleye harvested by anglers, with dates recovered and/or harvested, from walleye tagged during 2009, in Ririe Reservoir.

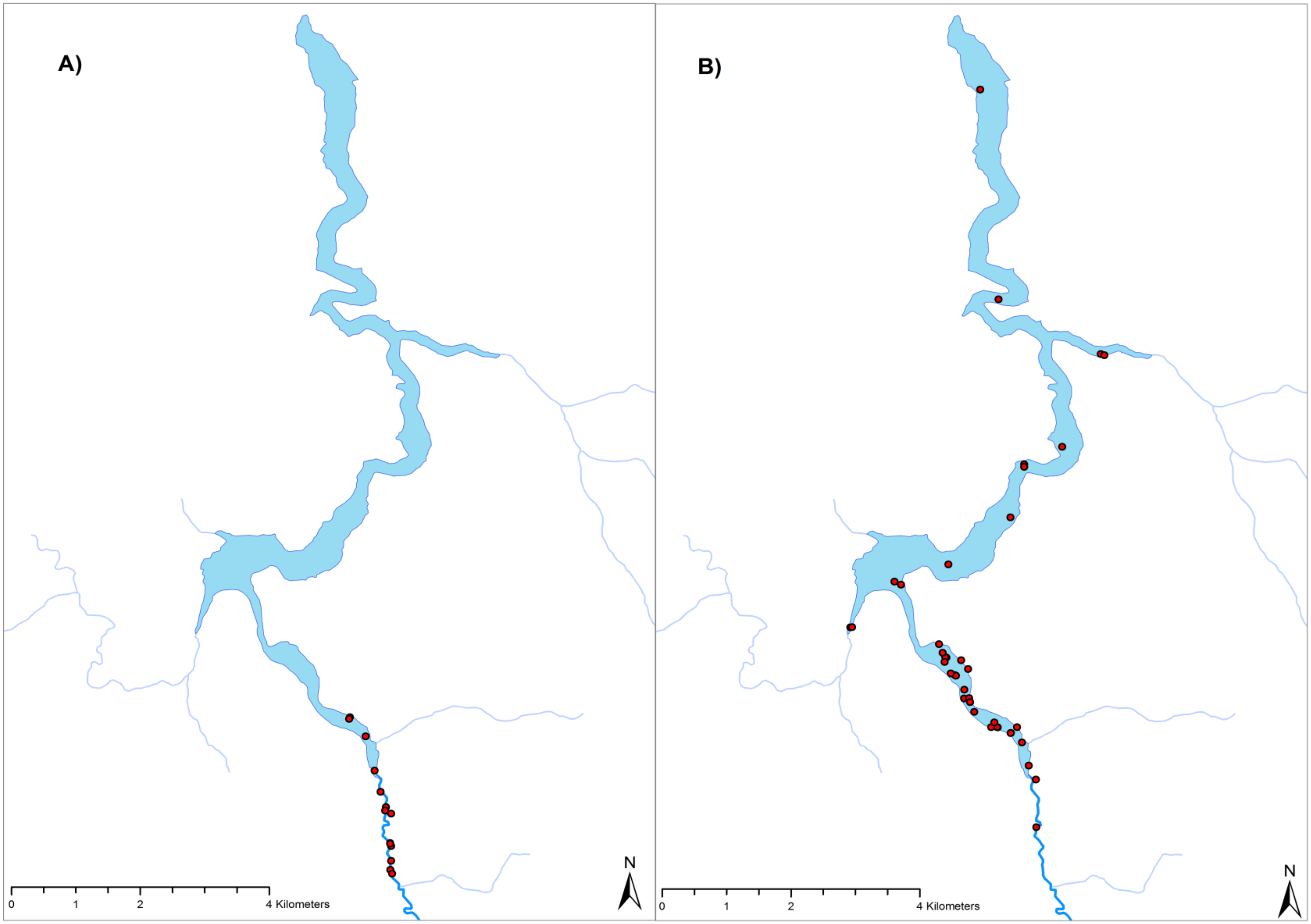


Figure 29. Locations of radio tagged walleye in Ririe Reservoir between A). April 20, 2009 and May 7, 2009 and B). May 22, 2009 and August 4, 2009.

Figure 30. Locations of radio tagged walleye in Ririe Reservoir between October 20, 2009 and December 4, 2009.

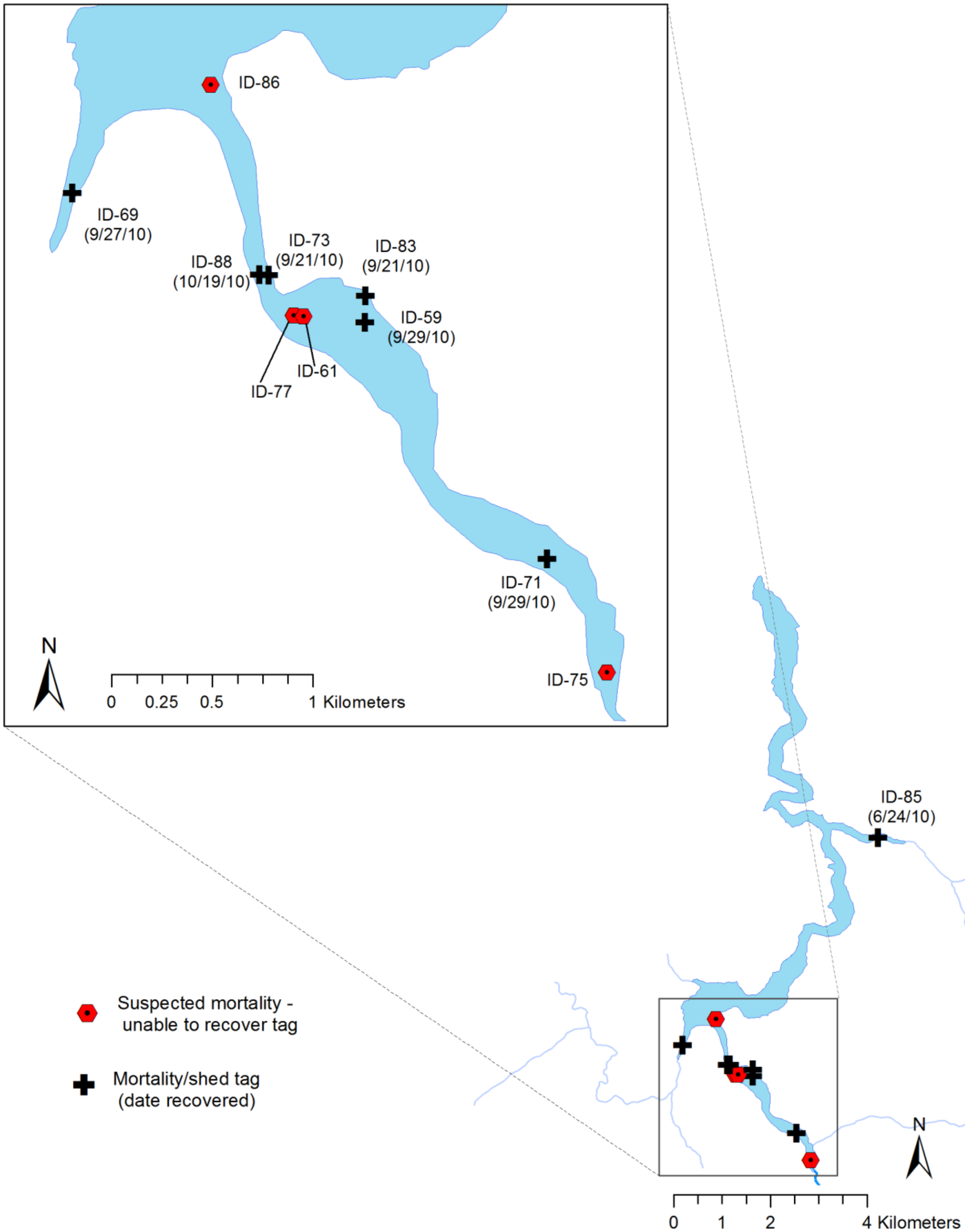


Figure 31. Suspected walleye mortalities and recovered walleye transmitters, with dates recovered, from walleye tagged during 2010, in Ririe Reservoir. Inset shows recoveries and suspected mortalities in the Willow Creek arm of Ririe Reservoir.

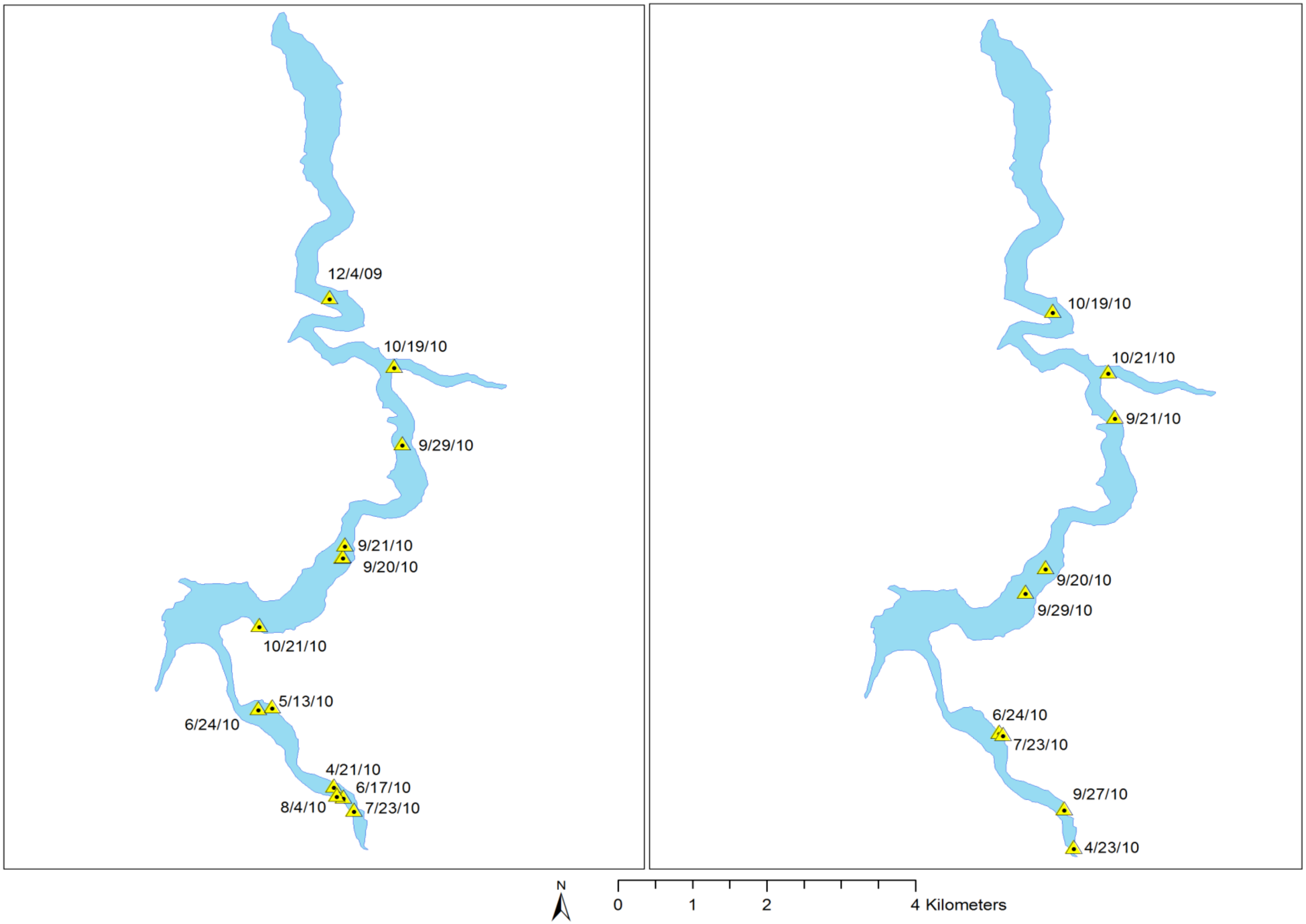


Figure 32. Locations from radio tagged walleye (A.) #72 and (B.) #79 in Ririe Reservoir during 2010.

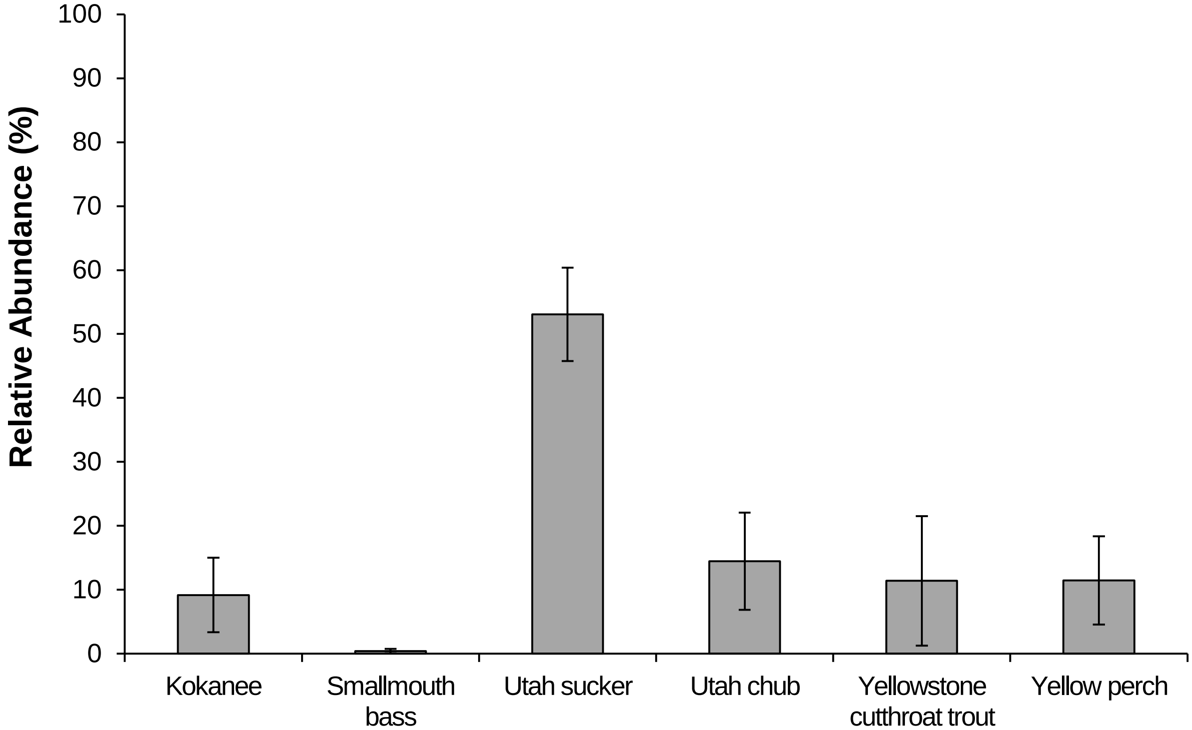


Figure 33. Catch composition from 2010 fall walleye index netting (FWIN) in Ririe Reservoir. Error bars represent 90% confidence intervals.

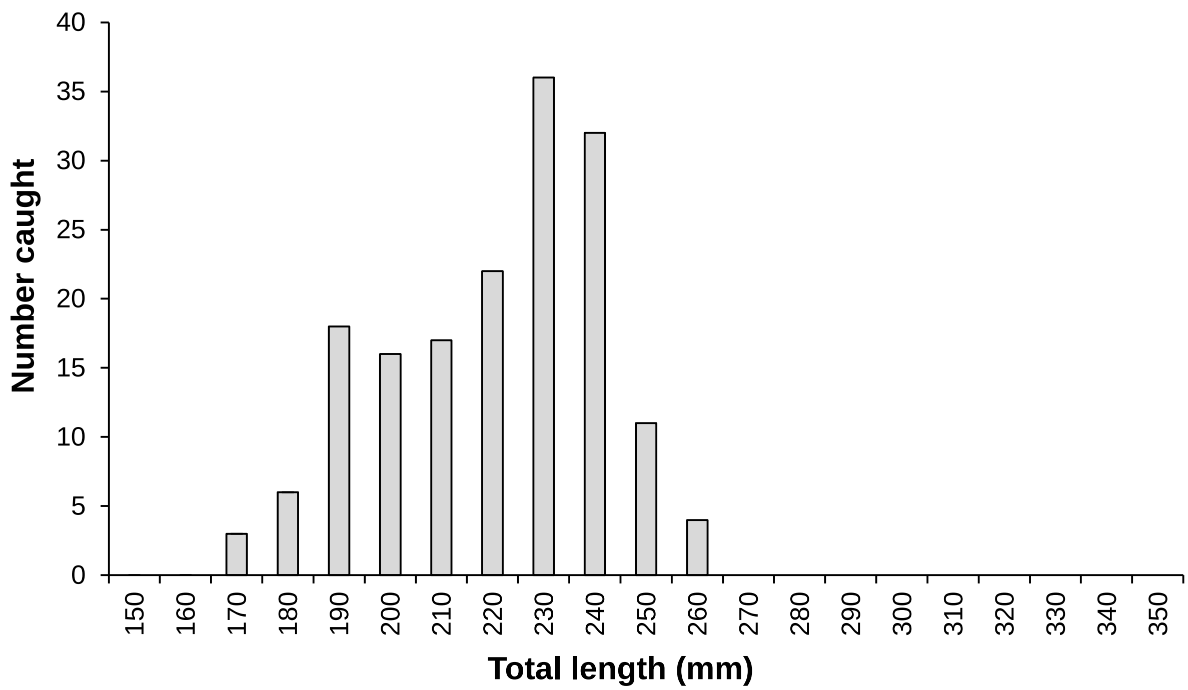


Figure 34. Length frequency of yellow perch captured during 2010 fall walleye index netting (FWIN) in Ririe Reservoir.

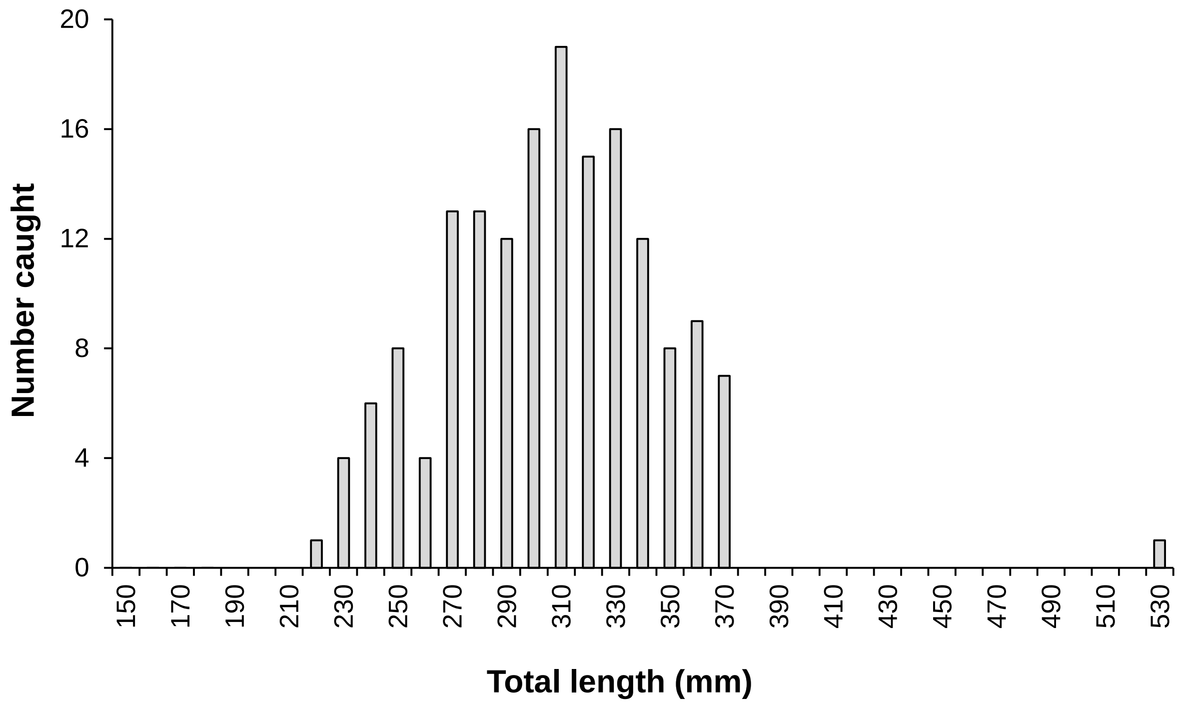


Figure 35. Length frequency of Yellowstone cutthroat trout captured during 2010 fall walleye index netting (FWIN) in Ririe Reservoir.

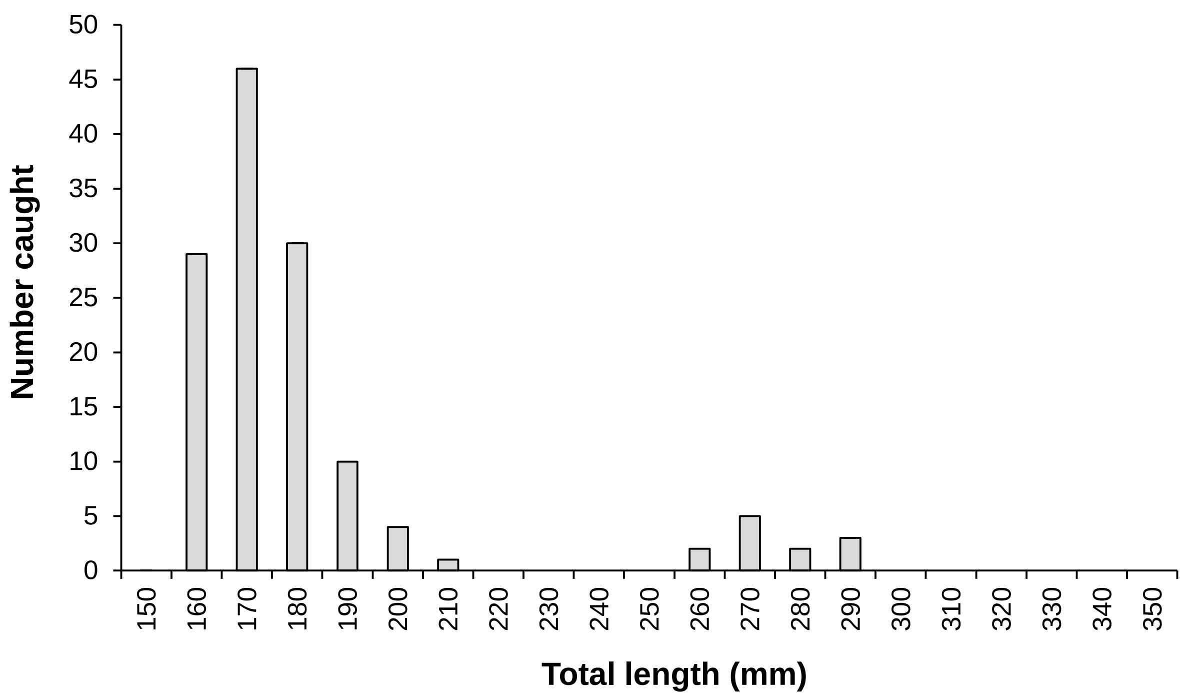


Figure 36. Length frequency of kokanee captured during 2010 fall walleye index netting (FWIN) in Ririe Reservoir.

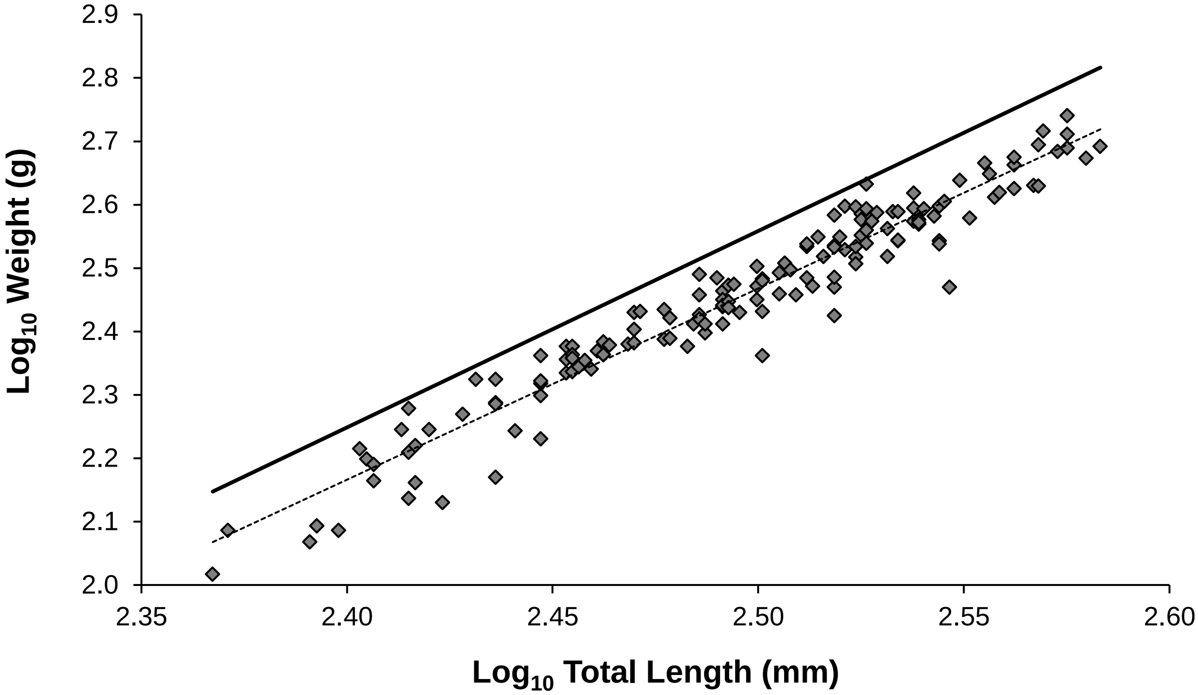


Figure 37. The relationship between total length (mm) and weight (g) of Yellowstone cutthroat trout in Ririe Reservoir (grey diamonds and dashed line) ($\log_{10}$ weight = 3.0174*[$\log_{10}$TL] – 5.0755; r^2 = 0.94). The solid line represents the standard weight (*Ws*) of the same population, using the formula from Kruse and Hubert (1997) ($\log_{10}$ weight = 3.099*[$\log_{10}$TL] – 5.189).

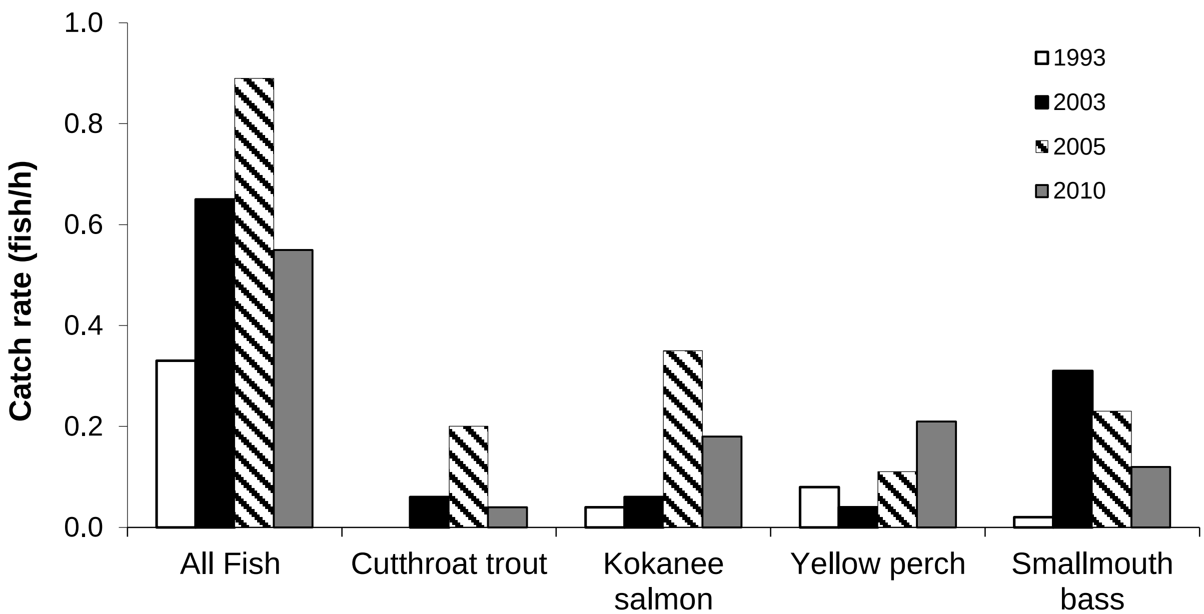


Figure 38. Catch rate (fish per hour) for total fish, cutthroat trout, kokanee salmon, yellow perch, and smallmouth bass from angler creel surveys conducted on Ririe Reservoir between 1993 and 2010.

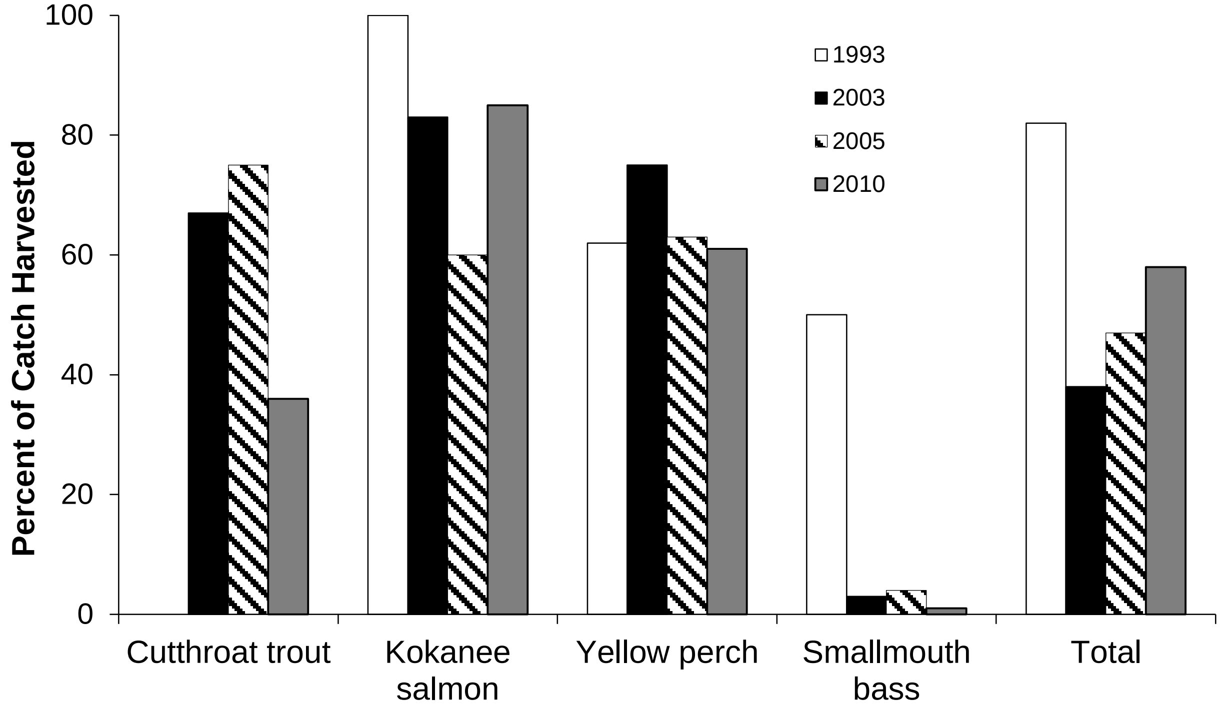


Figure 39. Percent of cutthroat trout, kokanee salmon, yellow perch, smallmouth bass, and total fish caught that were harvested from Ririe Reservoir between 1993 and 2010.

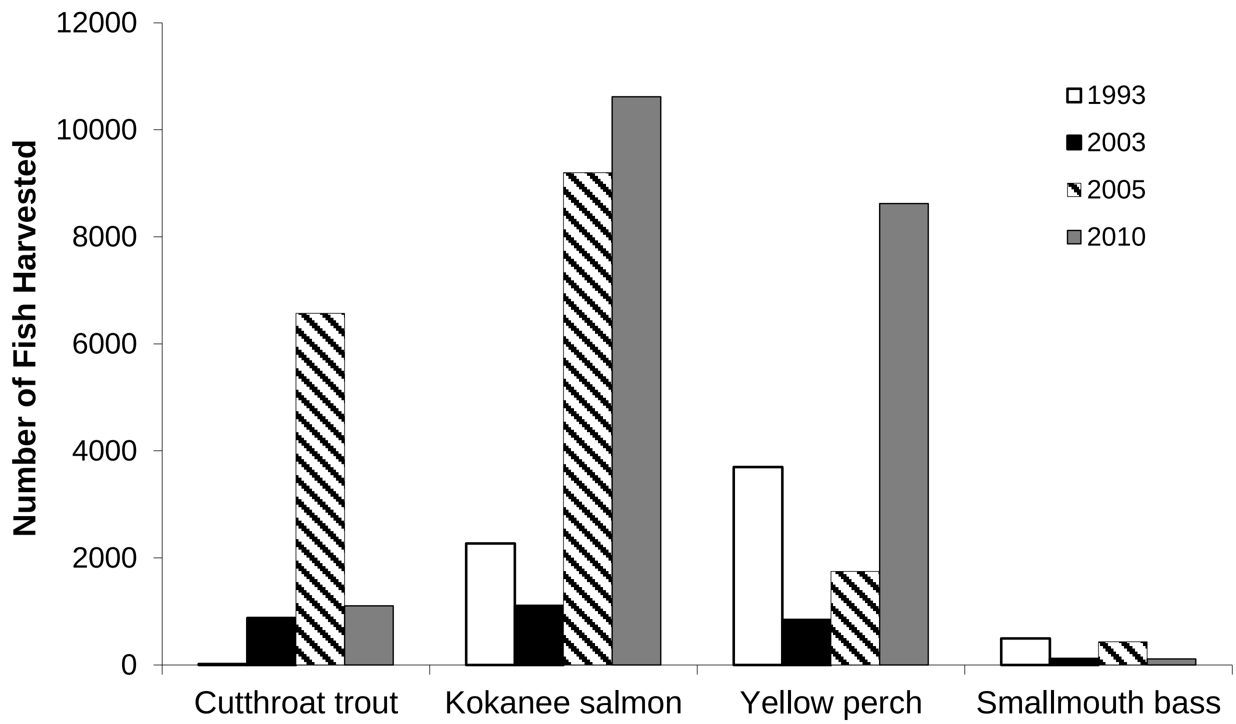


Figure 40. Number of fish harvested, based on angler creel surveys conducted on Ririe Reservoir between 1993 and 2010.

Table 10. Catch rates (catch per unit effort [CPUE]) and total number (n) caught for all species collected from Ririe Reservoir in 471 trap net nights during 2009 and 51 trap net nights during 2010.

	Utah sucker	Yellow perch	Utah chub	Yellowstone cutthroat trout	Smallmouth bass	Walleye
2009						
CPUE	10.6	10.0	2.3	0.5	0.03	0.01
n	4,981	4,702	1,105	256	13	4
2010						
CPUE	10.7	92.5	0.6	1.7	0.1	0.02
n	546	4,716	25	34	5	1

Table 11. Total length (mm) summary statistics for trap net caught game fish in Ririe Reservoir during 2009 and 2010.

	Yellowstone cutthroat trout		Walleye		Yellow perch	
	2009	2010	2009	2010	2009	2010
Mean	338	346	457	470	195	186
Median	335	338	445	--	198	186
Range	231 - 490	300 - 422	439 - 500	--	70 - 327	45 - 282
n	256	32	4	1	4,702	3,709

Table 12. Summary statistics (total length [mm] and mass [g]) for walleye implanted with transmitters in Ririe Reservoir during 2009 and 2010.

	Spring 2009	Fall 2009	Spring 2010
Number	20	2	21
Total length (mm)			
Mean	450	471	502
Minimum	402	465	447
Maximum	511	476	560
Mass (g)			
Mean	890	1,075	1,352
Minimum	545	1,050	775
Maximum	1,550	1,100	2,050

Table 13. Catch-per-unit-effort (CPUE) (fish per net night) by species captured during 18 net nights of fall walleye index netting (FWIN) on Ririe Reservoir during November 2010.

	Kokanee	Smallmouth bass	Utah sucker	Utah chub	Yellowstone cutthroat trout	Yellow perch
CPUE	7.3	0.3	42.4	11.6	9.1	9.2
Minimum	0	0	12	0	0	0
Maximum	29	2	81	39	51	39

Table 14. Angler statistics recorded for Ririe Reservoir, Idaho from creel surveys conducted between 1993 and 2010.

	1993	**2003**	**2005**	**2010**
Total Effort	56,612	25,981	43,825	68,364
Residency (Percent)				
Resident	98	96	96	96
Nonresident	2	4	4	4
Angler Type (Percent)				
Bank	55	16	3	25
Boat	45	83	72	45
Tube	0	<1	--	--
Ice	--	na	25	30
Gear Type Used (Percent)				
Bait	100	45	60	62
Lure	0	55	40	38
Fly	0	<1	<1	<1
Catch Rate (Fish Per Hour)				
All Fish	0.33	0.65	0.89	0.55
Cutthroat trout	0.00	0.06	0.20	0.04
Rainbow trout	0.19	0.07	0.01	--
Kokanee salmon	0.04	0.06	0.35	0.18
Yellow perch	0.08	0.04	0.11	0.21
Smallmouth bass	0.02	0.31	0.23	0.12
Crayfish	0.00	0.06	0.00	--
Number Harvested				
All Fish	17,600	5,020	17,968	20,451
Cutthroat trout	17	875	6,574	1,102
Rainbow trout	11,009	1,138	438	--
Kokanee salmon	2,268	1,106	9,203	10,618
Yellow perch	3,697	841	1,753	8,621
Smallmouth bass	496	111	438	110
Crayfish	0	949	0	--
Percent Harvested				
All Fish	82	38	47	58
Cutthroat trout	0	67	75	36
Rainbow trout	95	57	100	--
Kokanee salmon	100	83	60	85
Yellow perch	62	75	36	61
Smallmouth bass	50	3	4	1
Crayfish	0	100	0	--

Table 15. Comparison of creel survey results between the winter ice fishery and the open water fishery on Ririe Reservoir, during 2010.

	Ice	Open
Effort (hours)	20,456	47,908
Days in Survey Period	77	174
Residency (Percent)		
Resident	97	94
Nonresident	3	6
Angler Type (Percent)		
Bank	--	35
Boat	--	65
Ice	100	--
Gear Type Used (Percent)		
Bait	63	59
Lure	37	38
Fly	0	3
Catch Rate (Fish Per Hour)		
All Fish	0.38	0.91
Cutthroat trout	0.02	0.04
Kokanee salmon	0.34	0.08
Yellow perch	0.02	0.49
Smallmouth bass	0.00	0.31
Number Harvested		
All Fish	7,418	13,533
Cutthroat trout	270	832
Kokanee salmon	6,838	3,780
Yellow perch	354	8,267
Smallmouth bass	0	110
Percent Harvested		
All Fish	88	34
Cutthroat trout	66	32
Kokanee salmon	91	66
Yellow perch	70	47
Smallmouth bass	0	2

2010 Upper Snake Region Annual Fisheries Management Report

Rivers and Streams

SOUTH FORK SNAKE RIVER

ABSTRACT

The South Fork Snake River supports the strongest population of fluvial Yellowstone cutthroat trout (YCT) *Oncorhynchus clarkii bouvieri* in Idaho. This report summarizes management efforts to maintain YCT using a three-pronged approach that involves spawning tributaries, river flows, and harvest of rainbow trout (RBT) *O. mykiss*. Management is evaluated annually at the Conant and Lorenzo monitoring reaches. Total trout densities in 2010 were high at Conant with 2,865 trout/km which is 46% higher than the 10-year average of 1,956 trout/km. Total trout densities were down 30% at Lorenzo with 885 trout/km compared to the 10-year average of 1,259 trout/km. Estimates of YCT were significantly higher at Conant than in 2009, while brown trout *Salmo trutta* and RBT estimates were not statistically different. While not significant, the estimate for RBT was 17% lower in 2010 than in 2009. Thus, the new angler incentive study initiated to increase angler harvest of RBT may have resulted in increased harvest. We marked 575 RBT with coded wire tags worth $50 to $1,000 to anglers who turned in snouts from harvested RBT to the department. There were 3,048 RBT turned in through the angler incentive study with 18 winning fish, both of these numbers were lower than expected. We operated weirs and fish traps on all four major spawning tributaries and Indian Creek, a smaller tributary to the South Fork. YCT were collected in all streams, while RBT were captured and removed from all four major tributaries, but not Indian Creek. We used backpack electrofishers to remove 849 RBT from Palisades Creek between the fish trap and lower Palisades Lake. This effort will be repeated in coming years to assess whether electrofishing can suppress a resident RBT population. A creel survey was conducted during the snagging season on the Dry Bed. High water levels in the Dry Bed resulted in reduced effort (824 hr), catch (390), and harvest (279-84 YCT, 154 BNT, and 42 RBT) compared to previous years. The South Fork Snake River YCT population is increasing, but continues to face threats including non-native RBT and water diversions.

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INTRODUCTION

Yellowstone cutthroat trout *Oncorhynchus clarkii bouvieri* are the native trout of the South Fork Snake River (South Fork). The river supports the strongest remaining fluvial population within their historical range in Idaho (Thurow et al. 1988; Van Kirk and Benjamin 2001; Meyer et al. 2006a). Across the majority of the species range, Yellowstone cutthroat trout (YCT) have experienced dramatic reductions in abundance and distribution (Behnke 1992). In August 1998, conservation groups petitioned the United States Fish and Wildlife Service (USFWS) to list Yellowstone cutthroat trout under the Endangered Species Act (ESA). In February 2001, the listing petition was denied, and conservation groups filed a lawsuit in January 2004 which led to a 12-month review of the current status of YCT. The USFWS determined that YCT did not warrant listing under the ESA in February 2006 (USFWS 2006). However, YCT have continued to sustain declines in their abundance and distribution across their historical range (Koel et al. 2010).

The Idaho Department of Fish and Game (IDFG) altered management on the South Fork in 2004 to benefit YCT conservation, and the effectiveness of current management efforts are evaluated primarily with data from two monitoring sites sampled each fall. Current management efforts can be described as being three-pronged. The first prong deals with spawning tributaries and involves using fish traps on four main tributaries to remove rainbow trout and hybrids from spawning runs. Rainbow trout *O. mykiss* and rainbow x cutthroat trout hybrids (hereafter collectively referred to as RBT) are identified as the biggest threat to the continued persistence of YCT in the South Fork (Moller and Van Kirk 2003, IDFG 2007a; Van Kirk et al. 2010) because of risks through competition (Seiler and Keely 2007) and hybridization (Henderson et. al 2000). The second management prong deals with flow manipulation. Previous research has indicated flows similar to a natural (unregulated) hydrograph in both timing and shape, benefit YCT recruitment while limiting recruitment of RBT (Moller and Van Kirk 2003). The third management prong involves increasing angler harvest of RBT in the main South Fork. All three management prongs are designed to achieve the same goal, which is the preservation of the genetic integrity of YCT in the South Fork and the population's long-term viability (IDFG 2007a). Results from the annual electrofishing surveys of our two monitoring reaches are used to assess recruitment, population trend, and population densities which in turn are used to assess management effectiveness.

One key to the continued persistence of YCT in the South Fork is maintaining the four major spawning tributaries as refugia where YCT can spawn without risks of hybridization with rainbow trout. If RBT are allowed to invade the major spawning tributaries, then there may be little chance of securing long-term viability of YCT in the South Fork (Van Kirk et al. 2010). IDFG started constructing weirs and fish traps on spawning tributaries in 1996 and have been manually removing RBT from spawning runs since 2001 to limit RBT invasion and hybridization with YCT. IDFG has been limited by the low effectiveness of previous weirs and traps during high flows (Schrader and Fredericks 2006a). Recent weir modifications of converting picket or floating weirs to electrical weirs and a waterfall/velocity barrier have increased our effectiveness in trapping migrating salmonids during high spring flows (High et al. 2011).

Even though fish trapping efficiency has increased with the use of an electrical weir at Palisades Creek, hybridization risks still remain for fluvial YCT spawners due to the establishment of a resident population of RBT upstream of the fish trap prior to the construction of the weir and trap. Palisades Creek was the first tributary to support a wild population of RBT (Moore and Schill 1984). Due to the level of introgression in this resident population, it could be described as a "sport fishery" where introgression rates exceed 10% (IDFG 2007b). We are interested in reducing introgression rates to less than 10% (Conservation population status), and are curious if this could be accomplished using repeated annual electrofishing to remove RBT. While electrofishing has proven to not be effective at removing non-native brook trout (Thompson and Rahel 1996; Meyer et al. 2006b) the ineffectiveness has partly been blamed on the early maturation of brook trout which leaves little room to remove all individuals from the population before they mature (Meyer et al. 2006b). RBT do not mature as early as brook trout (Behnke 2002), which may allow repeated years of electrofishing to remove the bulk of immature individuals prior to maturation despite the fact that electrofishing is not 100% effective at capturing fish.

Anglers play a key role in YCT management efforts on the South Fork by harvesting RBT, but annual exploitation rates have been low. Exploitation rates have generally been less than 20% except for one year since 2004 (High et al. 2011; Schoby et al. 2010). Population modeling indicates exploitation must exceed 20% annually in combination with spring freshets and tributary spawning refugia to result in a decreasing RBT population in the South Fork (Van Kirk et al. 2010). In 2004, regulations changed on the South Fork, allowing year round fishing on the river along with no bag limits for RBT. This change resulted in a brief increase in harvest (Schrader and Fredericks 2006b). However, now that the regulations have been in place for six years, exploitation rates have decreased. Thus, a program that provides an incentive for RBT harvest may increase exploitation. An incentive program has successfully been implemented on Lake Pend Oreille to increase harvest rates of lake trout *Salvelinus namaycush* and rainbow trout (J. Fredericks pers. communication), and may prove beneficial on the South Fork.

Irrigation diversions on the South Fork negatively affect the YCT population through entrainment. The largest diversion is the Great Feeder Diversion which diverts as much as 142 m^3/s (5,000 cfs) during peak irrigation months down the Dry Bed, a former side channel of the river converted into a canal. Entrainment of YCT into the Dry Bed and other canals acts as a sink for the YCT population because entrained fish have little opportunity to return to the South Fork. While entrainment into irrigation diversions such as the Great Feeder is known to be a factor acting against a healthy YCT population in the South Fork (High et al. 2011), the magnitude of entrainment has not been quantified. A minimum estimate of entrainment could be obtained by performing a creel survey on the Dry Bed snagging season which occurs each April. The Dry Bed is wetted nearly 11 months of each year. In April, the headgates are shut to allow the thirteen secondary canals diverting water from the Dry Bed to perform maintenance on their headgates. During this time, IDFG has allowed game fish to be legally harvested by snagging, dip nets, and by catching fish with your hands. However, this method would severely underestimate total entrainment, as fish entrained into secondary canals would be unavailable to anglers. Further, anglers target larger fish during this snag season, resulting in a biased estimate. Lastly, this method cannot estimate abundances of fish left in the Dry Bed that anglers did not harvest. Because of these limitations, estimates of entrainment using a creel survey should be viewed as a minimal estimate.

This report summarizes efforts to conserve YCT in the South Fork during 2010. A fluvial population of YCT continues to be supported by habitat in the South Fork, but its long-term viability is threatened by a burgeoning non-native RBT population, entrainment into irrigation diversions, and other factors.

OBJECTIVES

1. Determine whether management actions from the three-pronged management approach on the South Fork Snake River are helping to conserve YCT.

2. Reduce hybridization risks by providing spawning refugia for YCT in the major spawning tributaries.

3. Increase angler harvest rates of RBT in the South Fork.

4. Reduce the resident rainbow trout population in Palisades Creek upstream of the weir using multiple years of single pass electrofishing.

5. Obtain a minimum estimate of YCT loss from the South Fork into the Dry Bed.

STUDY AREA

The Snake River originates in Yellowstone National Park and flows south through Grand Teton National Park and the Jackson Hole valley before turning west and flowing into Palisades Reservoir at the Idaho – Wyoming state line. The 106 km portion of the Snake River that runs from Palisades Dam to the confluence with the Henrys Fork is commonly referred to as the South Fork. Anglers and biologists divide the South Fork into three segments. The first segment, called the upper river, runs from Palisades Dam to Pine Creek through a relatively unconfined valley. The first 13 km of the upper river downstream of the dam is a simple channel. From this point, the river braids around numerous islands. All but one of the four main YCT spawning tributaries enters the South Fork in this upper river, including Palisades Creek, Rainey Creek, and Pine Creek (Figure 41). The second segment of the South Fork runs from Pine Creek downstream to Heise, and is commonly referred to as the Canyon. Burns Creek, the fourth major YCT spawning tributary enters the South Fork in the Canyon. The last segment of the South Fork runs from Heise to the confluence with the Henrys Fork, and is commonly referred to as the lower river. There are no major YCT spawning tributaries in the lower river, and while constant water temperatures from Palisades Dam moderate winter conditions in the upper and canyon sections, winter conditions in the lower river are usually more severe than upstream (Moller and Van Kirk 2003). The Conant and Lorenzo monitoring reaches of the South Fork are in the upper-river and lower-river sections, respectively. In addition to native YCT, other salmonids in the South Fork include RBT, brown trout *Salmo trutta*, and mountain whitefish (also native). Utah sucker, bluehead sucker *C. discobolus*, and mountain sucker *C. platyrhynchus* are the native catostomids in the South Fork.

METHODS

South Fork Population Monitoring

We estimated trout abundances at the Lorenzo and Conant monitoring reaches of the South Fork during the fall when river flows decreased after the main irrigation season. Estimates were calculated separately for each species and only included age 1 and older trout (see Schrader and Fredericks 2006a). We used the MR5 program (developed by the Montana

Department of Fish, Wildlife, and Parks) to calculate population estimates and 95% confidence intervals (CIs) using the Log-likelihood method and 25 mm size groups. We compared 2010 trout estimates to previous years based on overlapping (not significant) or non-overlapping (statistically significant) 95% CIs. We attempted to estimate abundance of the separate sucker species at both monitoring reaches, but were unable to do so because of lack of recaptured individuals with marks. We used electrofishing gear mounted to a jet boat to capture fish. We used pulsed direct current (DC) at 5 amps, 200 – 300 volts, 50% pulse width, and a frequency of 80 Hertz. Captured fish were identified and measured (total length). We marked captured fish in the caudal fin with a hole punch on our marking runs, and used this mark to identify previously captured fish in our recapture runs. We sampled the Lorenzo monitoring reach September 20-21 (marking runs) and September 27-28 (recapture runs). We sampled the Conant monitoring reach October 13-15 (marking runs) and October 19-20 (recapture runs).

Weirs

Migration barriers and traps were installed at all four of the main spawning tributaries of the South Fork and maintained during the 2010 spring spawning run. An additional picket weir and upstream trap was installed and maintained on Indian Creek, a small tributary entering the South Fork between Rainey Creek and Palisades Creek from the south side of the river. Weir installation dates for 2010 were selected to maximize potential to capture migrating RBT. Fish traps were installed before the earliest dates RBT have been captured in the respective traps to date, excluding Indian Creek where we trapped spring migrants for the first time in 2010. The fall/velocity barrier and adjacent fish ladder and trap at Burns Creek trap was operated from March 26 through July 14. The newly modified electric barrier at Pine Creek was operated from March 13 through July 5. A picket weir was also used at the Rainey Creek fish trap from April 13 through June 29, with six days (June 4 – June 10) when the weir was inoperable due to high water. An electrical barrier was used at the Palisades Creek fish trap from March 19 through July 18. A picket weir and upstream trap was operated in Indian Creek from April 29 through July 9.

All fish captured at Burns, Pine, Rainey, Palisades, and Indian creeks were identified to species, sexed according to expression of milt or eggs or head morphology, and measured to the nearest mm (total length). Yellowstone cutthroat trout were marked with a PIT tag or a caudal fin punch and released upstream of the weir. We removed the adipose fin from cutthroat trout that received PIT tags as a secondary mark to evaluate tag loss and make scanning for PIT tags more efficient. All cutthroat trout captured in the trap with adipose fin clips were scanned for PIT tags. RBT were removed from the runs, placed in a holding pen at the Palisades Canal screen yard, and later transported to the Victor kids (Trail Cr.) pond.

We investigated migration timing relative to year, effects of sex on migration timing, and sex compositions at each of the four main spawning tributaries in the South Fork. We compared the timing of cutthroat trout spawning runs in the four main spawning tributary streams using linear regression on each tributary to assess whether runs in recent years occur at later calendar dates. We compared the timing of male and female cutthroat trout capture events at each of the four main spawning tributaries using separate median tests. We used a single ANOVA to compare sex ratios of spawning runs at all four spawning tributaries during years when capture efficiencies exceeded 75% or when total catch was greater than 75% of the stream-specific median total catch for all years with available data. We used the efficiency and catch criteria to remove bias from years when only part of the spawning runs were captured at the weirs which could bias sex ratios depending on which part of the spawning run was ineffectively captured.

We estimated efficiencies for the traps at Burns and Palisades creeks. We used backpack electrofishing units to capture trout upstream of the Burns Creek trap to obtain a percentage of marked fish, indicating cutthroat trout that had been handled at the trap. A secondary trap for downstream migrants on the Palisades Canal screen bypass was used to estimate trap efficiency at Palisades Creek. We could not evaluate trap efficiencies at Rainey Creek or Pine Creek. In Rainey Creek, we captured too few cutthroat trout (n=145) to allow for trap efficiency evaluation, and efforts to recapture marked cutthroat trout in Pine Creek upstream of the weir were unsuccessful. The Palisades Canal bypass trap was operated from July 10 through July 23. Efficiencies were calculated as the number of cutthroat trout ≥ 284 mm with PIT tags or caudal fin punches divided by the total number of cutthroat trout ≥ 284 mm. The 284 mm length cutoff was identified because it was 1.96 standard deviations less than the average total length of all cutthroat trout captured at fish traps in 2010, and effectively eliminates skewing error resulting from resident YCT.

South Fork Angler Incentive Study

In 2010, we initiated the South Fork Angler Incentive Study to determine if monetary rewards and community service opportunity could increase harvest rates of RBT in the South Fork. During January and February 2010, 575 RBT were marked with coded wire tags (CWT) in the snout. We captured, tagged, and released RBT from Palisades Dam downstream to Heise. The tags were etched with five different six-digit numbers corresponding to the following monetary values: $50, $100, $200, $500, and $1,000. The breakdown of the number of RBT marked with the different dollar amounts were as follows: $50-300, $100-200, $200-50, $500-20, and $1,000-5. A substantial outreach effort was made to inform the public of this new program including brochures, presentations to local fishing clubs, outfitters and guides, media releases in the form of print and T.V., and YouTube. Anglers wishing to participate in the program were required to turn in the heads of RBT to the IDFG regional office directly or via freezers placed at the Byington and Conant boat ramp areas. On the first Friday of every month, we scanned the heads that had been turned in for CWTs. When CWTs were found, the angler was notified to verify the address and inform them of the amount of money they would receive.

Anglers not only could receive money for winning fish turned in, but they also had an opportunity to provide food to local families and individuals in need. Non-consumptive anglers who wished to participate in the program could harvest fish and donate their catch via the same channels used to turn in heads, but could turn in the cleaned fish carcass which was in turn given to the Eastern Idaho Community Action Partnership to distribute to local people in need of food.

The South Fork angler incentive study was planned to be a two year study with the CWT values valid through December 2011. At the conclusion of the study, we will compare the estimates of exploitation with estimates of exploitation from 2004 through 2009 to determine if the study was successful at increasing angler harvest of rainbow trout.

Rainbow Trout Removal in Palisades Creek

We used tandem backpack electrofishing units to remove RBT from 10.5 km of Palisades Creek from the Palisades Creek weir upstream to Lower Palisades Lake (10.5 stream km). We conducted a single pass electrofishing assessment from October 25 – 28. RBT were identified based on phenotype. The primary characteristics used to identify species were the presence of white tips on the ventral and dorsal fins, spotting pattern, and body coloration. All captured RBT were removed from Palisades Creek while YCT were returned to the stream. RBT captured between the Palisades Creek weir and the US Forest Service boundary were donated to the Eastern Idaho Community Action Partnership, and RBT captured on US Forest Service property were euthanized and left on-site. All captured trout were identified and measured (TL). Catches were summarized for each 0.8 stream km (13 total sections). We randomly collected genetic samples from 30 trout from each 0.8 km stream section for a total of 390 samples. Genetic samples will be analyzed in 2011.

PIT tags

In 2010, we again marked YCT with Passive Integrated Transponder (PIT) tags in continuation of an effort started in 2008 to assess general movement patterns, spawning stream fidelity, duration cutthroat remain in spawning tributaries, river-wide population abundance, and population growth rates. We marked YCT when handling fish during tributary weir operations, fall population surveys, weir efficiency surveys, and during winter electrofishing efforts that are part of the angler incentive study. We recorded the date, TL, and stream location for each PIT-tagged YCT. The presence of hook or bird scars was also noted. The sex of individual YCT was recorded when fish were PIT-tagged at a tributary weir. We removed the adipose fin on PIT-tagged fish to facilitate easier identification of marked individuals during recapture events and for the evaluation of tag loss.

Dry Bed Creel

An access point creel survey was conducted on the Dry Bed Canal during the snagging season from April 1 through April 3, which corresponded to the majority of the time that anglers sought after fish stranded in the Dry Bed in 2010. After April 3, fishing effort dropped dramatically with water levels in the remaining pools too high to effectively snag fish. Total effort, catch, and species composition was estimated based on completed trip surveys. Analysis was completed using the simple combination survey method as explained by Pollock et al. (1994). We completed one instantaneous count on each of three days by driving along the dry bed in a vehicle and counting anglers. Instantaneous counts showed creel clerks would be most likely to encounter anglers upstream of the bridge at 4500 East at two to three locations. Two clerks were stationed at these locations from 8:00 am to 6:00 pm (approximately 75% of daylight hours), and interviewed anglers as they concluded their fishing trips. Creel clerks asked anglers how long they fished, how many fish they caught by species, how many trout they harvested (by species), and recorded fish lengths of harvested trout. Daily fishing effort was calculated by multiplying the instantaneous count value by the fishing day length. Total fishing effort was calculated by summing daily fishing effort estimates for all four days. The catch rate for all trout species combined was estimated by dividing total trout caught by the total hours spent snagging. The harvest rate for all trout species combined was estimated similar to catch, but total trout caught was replaced by total trout harvested. We then multiplied the catch rate and total effort estimate to calculate total trout caught. Likewise, we multiplied our harvest rate and effort to obtain an estimate of the total number of trout harvested. Variance estimates for total catch, total harvest, and total fishing effort was calculated by averaging the daily values of variance for the respective statistic of interest.

RESULTS

South Fork Population Monitoring

We captured 1,343 trout at the Lorenzo monitoring reach, including 196 YCT, 18 RBT, and 1,129 BNT. We also captured 245 suckers, including 243 Utah sucker and 2 bluehead suckers. Our abundance estimates for age 1 and older YCT (≥102) and BNT (≥178) were 233 and 633 trout per kilometer, respectively (Table 16; Figure 42). Density estimates for YCT in 2010 were similar to available estimates back to 1999. Non-overlapping 95% confidence intervals indicated brown trout estimates from 2010 were significantly lower than the 2009 estimate (Figure 42). An abundance estimate for RBT has never been possible in the previous 15 surveys at Lorenzo, and was again not possible for RBT with only 1 marked fish captured during the recapture runs in 2010. With a total trout estimate of 956 trout/km and RBT comprising 1.3% of the catch, we extrapolate a RBT estimate of 12 RBT/km in the Lorenzo reach in 2010. We were not able to estimate abundance of either sucker species. We observed a single Utah sucker recapture from the 115 Utah sucker marked.

We captured a total of 1,627 trout at the Conant monitoring reach. This included 710 YCT, 439 RBT, and 478 BNT. We captured 54 Utah sucker and did not observe bluehead sucker during the Conant survey. We estimated there were 1,211 YCT/km (±284), 1,174 RBT/km (±666), and 479 BNT/km (±136) of age 1 and older trout (Figure 43). The 2010 estimates for RBT and YCT per km were nearly identical and statistically, there was no difference between these estimates as their 95% confidence intervals overlap. The total trout abundance at Conant (2,295 trout/km) approached our all-time high estimate of 2,984 trout/km from 1990 (Table 17). Forty-one percent of the total trout abundance at Conant consisted of RBT. We were not able to estimate abundance of Utah sucker with a single recaptured fish.

Weirs

We operated the Burns Creek weir between March 26 and July 14, 2010 and started capturing fish May 23. We captured 1,552 trout including 1,550 Yellowstone cutthroat trout and two rainbow trout (Table 18). By June 23, 50% of the Yellowstone cutthroat trout run had passed the Burns Creek trap. The average date of 50% passage of YCT at the Burn Creek trap was June 12 for 5 years of data between 2001 and 2009. Linear regression results indicate 50% passage dates for YCT at Burns Creek have recently been occurring at significantly later dates than previous years ($P=0.04$; $F = 9.63$; $df = 5$; $r^2 = 0.71$; Figure 44). By June 12, 50% of the male YCT captured at Burns Creek had passed the fish trap, while 50% of the female YCT had passed by June 15 (Figure 45). The median test comparing median passage dates for male and female YCT was not statistically significant with $P>0.25$ (Chi-square = 1.33, df = 1) indicating male and female YCT run timing at Burns Creek has been similar. The observed sex ratio for YCT captured at Burns Creek in 2010 was 57% females, 43% males. We captured 54 fluvial YCT upstream of the fish trap on July 9. All of these fish were previously captured in the fish trap, yielding a trapping efficiency estimate of 100%.

We operated the Pine Creek trap from March 13 to July 5 and we captured the first fish on May 20, 2010. We captured 2,975 trout including 2,972 YCT and 3 RBT (Table 18). On June 18, 2010, 50% of the YCT run had passed the Pine Creek trap (Figure 44). The average 50% passage date for six previous years of data between 2002 and 2009 was June 10. The recent run timing for YCT in Pine Creek have not been different than previous years as indicated by a non-significant linear regression (P=0.31, F = 1.29, df = 6; r^2 = 0.21). Half of the male YCT passed the Pine Creek trap on June 10 compared to June 13 for female YCT for 7 years of data between 2002 and 2010 (Figure 45). This slight difference was not statistically significant in a median test (P>0.75, Chi-square = 0.29, df = 1). In 2010, male YCT comprised 33% of the run and females made up 67% of the run.

We captured 145 YCT and one RBT at the Rainey Creek weir between April 13 and June 29, 2010 (Table 18). We captured the first cutthroat trout on May 15th. By June 19, 50% of the YCT run had passed the Rainey Creek trap. The long-term average 50% passage date for YCT at Rainey Creek was June 2 for four years of data between 2005 and 2009 (Figure 44). However, total YCT catch for all of these years was between 14 and 69 trout and no trap efficiency estimates are available. When we analyzed 50% passage dates for YCT at Rainey Creek using linear regression, the results were not significant (P=0.13, F = 4.20, df = 4; r^2 = 0.58) indicating run timing has not changed. For four years of data between 2005 and 2010, 50% passage dates of male YCT was May 11 compared to May 23 for female YCT (Figure 45). This difference was not significant in a median test (P>0.75, Chi-square = 2.00, df = 1). In 2010, male YCT comprised 35% of the run and females comprised 64% of the YCT run in Rainey Creek.

We operated the Palisades Creek fish trap from March 19 through July 14, 2010 and, captured the first trout on March 20. We caught 545 YCT and 50 RBT (Table 18).On June 28, 50% of the YCT had passed the Palisades Creek trap compared to a long-term average 50% passage date of June 14 for seven previous years of data collected between 2001 and 2009 (Figure 44). The 2010 date was not statistically different then the long-term average in a linear regression analysis (P = 0.09, F = 4.13, df = 7; r^2 = 0.41). From eight years of data between 2001 and 2010, half of the male YCT passed the Palisades Creek trap by June 13 and half of the female YCT passed by June 15 (Figure 45). The slight difference in passage dates for male and female YCT was not statistically different in a median test (P>0.75, Chi-square = 0.40, df = 1). In 2010, male YCT comprised 29% of the run and females comprised 71% of the run. We captured 88 fluvial YCT in the bypass channel for the Palisades Canal and 76 of these had been captured in the Palisades trap, yielding an efficiency estimate of 86%.

We did not find statistical evidence to indicate a difference in sex ratios of YCT runs at any of the four major spawning tributaries of the South Fork. We included years of data when capture efficiencies exceeded 75% and/or total catch exceeded 75% of the long-term median catch. This resulted with the inclusion of 5 years of data for Burns Creek, 4 years from Pine Creek, 2 years from Rainey Creek, and 6 years from Palisades Creek. During each of these years, females outnumbered males with an overall average composition of 37% male and 63% female. ANOVA results indicate no statistical difference in the number of male versus female YCT at the α = 0.05 level (P=0.06, F = 3.81, df = 32).

We captured three Yellowstone cutthroat trout at the Indian Creek fish trap in 2010 between April 29 and July 9, 2010. Two of these YCT were males captured on June 30 followed by a single female YCT on July 7. The trap was functional for the entire trapping season, and we believe capture efficiencies were high for fluvial trout. No RBT were captured at Indian Creek.

South Fork Angler Incentive Study

During 2010, a total of 3,048 RBT were turned in by 683 anglers to be checked for the presence of coded wire tags (CWT). Tag awards included 12-$50 tags, three-$100 tags, two-$200 tags, and one-$1,000 tag. Anglers turned in an average of 3.6 heads/turn-in event ranging from 1 to 102 (median of 2). Winning anglers turned in an average of 18 RBT ranging from 1 to 102 (median of 9). Only two anglers turned in multiple winning fish, two each. Fifteen of the seventeen winning anglers were Idaho residents while the remaining two were from California and New Jersey. Most of the anglers that participated in the study (77%) did not use bait, and most of the anglers (87%) kept all of the RBT they caught.

Rainbow Trout Removal in Palisades Creek

We removed 849 RBT from Palisades Creek between the Palisades Creek weir and Lower Palisades Lake. Most RBT were captured in the middle of the reach between 3.2 and 8.0 stream km upstream from the Palisades Creek weir. As crews neared Lower Palisades Lake, RBT were less abundant, similar to abundances closer to the fish trap downstream. In the middle section, however, RBT often comprised 50% of trout abundance (Figure 46).

PIT tags

In 2010, we marked an additional 3,884 YCT with PIT tags bringing the total number of marked YCT released in the South Fork Snake River since 2008 to 9,027. We recorded 1,195 recapture events. We replaced lost tags on 225 of the 1,195 recaptured fish, indicating tag loss was 19%. Most recapture events for individual PIT-tagged YCT occurred at the same site they were originally tagged (Table 19). Spawning tributary fidelity was 100% for 396 PIT-tagged YCT recaptured at tributary weirs where they were originally tagged. Some evidence of lengthy migrations was apparent for fish marked and recaptured at different locations (Table 19).

Dry Bed Creel

We collected 98 completed trip interviews during the three days of the creel survey and observed 87 harvested trout. The composition of the observed harvest was 30% YCT, 55% BNT, and 15% RBT. Anglers reported 209 hours of fishing effort. We estimated total fishing effort and 95% confidence interval (CI) at 824 hours (±136). The overall catch rate was 0.5 fish per hour with an estimated total catch of 390 (95% CI = 99 to 1,493). The overall harvest rate was 0.3 fish per hour with an estimated total harvest of 279 trout (95% CI = 232 to 325). Assuming harvest composition was similar to observed harvest, we estimate 84 YCT, 154 BNT, and 42 RBT were harvested during the Dry Bed snagging season.

DISCUSSION

South Fork Population Monitoring

Results from the 2010 electrofishing surveys showed high abundances of trout in both sample reaches. The total trout estimate at the Conant monitoring reach (2,865 trout/km) was higher than the 2009 estimates and is the third highest out of 21 years of sampling. The all time high density was recorded in 1999 and was slightly higher at 3,013 trout/km. Although the point estimate in 2010 was lower than 2009, RBT are still abundant in the South Fork, especially in the upper river where the Conant monitoring reach is located. RBT significantly outnumbered YCT for the first time at Conant in 2009. Recent population density trends for trout at Conant provide some indication that management efforts on the South Fork are benefitting YCT. The point estimates for YCT and BNT abundance increased in 2010 while the RBT point estimate decreased. We would expect trends to be similar for all species as all trout in the Conant reach were subject to the same environmental conditions (High et al. 2008). Thus, it is likely management efforts through the three-pronged management approach combined with the new Angler Incentive Study have caused rainbow trout abundance to decline. Although this change does not represent a statistically significant decrease, the reduced rainbow trout point estimate is encouraging. Spring flows during 2009 did not coincide with the timing of a natural spring freshet, and thus were expected to have limited effectiveness at minimizing RBT recruitment. The 2009 freshet peak occurred in early July. Based on our current understanding, freshets that peak later than June 1 do not hamper rainbow trout spawning success (Moller and Van Kirk 2003; High et al. 2011). The fact that we did not see another increase in RBT abundance in 2010 may indicate management efforts are successfully reducing the RBT population in the South Fork. Another encouraging finding from our 2010 monitoring was a statistically significant increase in YCT abundance over the 2009 estimate, which is likely the result of favorable flow conditions as well as management effects from the three-pronged approach geared to benefit YCT. The estimate for brown trout was higher in 2010, but the increase was not statistically significant. Brown trout are not native to the South Fork, but do not appear to be limiting the conservation of native YCT. Unlike RBT, we have recorded high densities of YCT despite the presence of BNT in past years at abundances similar to what we observed in 2010, suggesting these two species may not be mutually exclusive in the South Fork. However, if brown trout densities continue to increase, this may be cause for concern relative to YCT conservation. The presence of BNT have been linked to declines of cutthroat trout abundance and/or distribution in Utah (Budy et al. 2007; Budy et al. 2008) and Montana (J. Wood, Montana Fish Wildlife and Parks, personal communication). Overall fish abundance trend data from the South Fork for 20 years of data show no correlation between BNT and YCT abundances. The increasing trend in BNT abundance warrants additional monitoring to ensure YCT can and will persist.

At the Lorenzo monitoring reach, brown trout continue to dominate trout composition. Densities found in 2010 had declined from those found in 2009. However, compared to the last 10 years, the 2010 estimate is within the range of variability observed over that time period. BNT density estimates likely vary from year to year at the Lorenzo reach because of annual habitat changes in the monitoring reach. The channels in the lower section of the South Fork change often, especially during high water years which have recently occurred. The Lorenzo monitoring reach is long (4.8 km) in an attempt to minimize bias caused by habitat alterations. However, this may be one reason why we see variability in BNT densities from year to year as well as variability in the other trout density estimates. YCT in the Lorenzo reach appear to have a stable population with abundance estimates from 2010 being similar to available estimates dating back to 1999.

Weirs

Based on the numbers of trout captured at each of the major spawning tributaries, 2010 was the most successful year to date since trapping efforts began in 2001. Recent efforts to increase trapping efficiencies through modified structure designs have enhanced our ability to successfully trap migrating fish during run-off conditions. We estimated high trap efficiencies at Burns Creek (100%) and Palisades Creek (86%), and although we were unable to obtain efficiency estimates at Pine and Rainey creeks, we believe our efficiencies were high there as well because we captured more YCT at both of these locations in 2010 than in any previous year.

We anticipate continued increases in trapping efficiencies in coming years with the completion of the new Rainey Creek electric weir and some fine-tuning of our trapping efforts. Construction of the new Rainey Creek electrical barrier and fish trap was initiated in October 2010. The previous weir location was 15 stream km upstream from the South Fork. The new Rainey Creek fish trap will be located closer the mouth of Rainey Creek (5 km) and will allow IDFG to protect more YCT spawning habitat from RBT invasion. The new trap should be operational for the spring 2011 spawning run. We believe we can increase trapping efficiencies at the Palisades Creek electric weir. We suspect trapping efficiency was not 100% effective at Palisades Creek because of a connection between Palisades Creek downstream of the trap and Palisades canal at an old diversion. YCT that enter Palisades Canal through the old diversion can swim upstream and back to Palisades Creek upstream of the fish trap. We will block fish passage into Palisades Canal from Palisades Creek at the old diversion in 2011 and reassess trapping efficiency.

Although YCT runs have arrived roughly one week later at spawning tributaries to the South Fork in the last two years, the trend does not appear to be substantial, except at Burns Creek. The timing of YCT spawning runs is affected by stream flow (Ball and Cope 1961; Thurow and King 1994), temperature (Jones et al. 1990), and cover including turbidity (Giger 1973). All of these factors are correlated and are affected by climate change (Isaak et al. 2010). The expected result of climate change on YCT runs in the South Fork could include later run timing, resulting in a shorter growing season which could negatively affect populations through decreased overwinter survival of age 0 fish because of decreased size (Smith and Griffith 1994). The timing of YCT runs remains similar to past years with available data at all of the spawning tributaries except Burns Creek. We did detect a significant difference in run timing for YCT in Burns Creek. One explanation of this could be due to the fact that Burns Creek is spatially segregated from the other three spawning tributaries. Pine, Rainey, and Palisades creeks are neighboring drainages, all in the upper river, while Burns Creek is located downstream in the canyon. Another possible explanation could be the effects of the new barrier (a combination waterfall and velocity barrier) used at the trap site since 2009. Both spring runs of YCT at Burns Creek were later than all previous runs for both years that the new barrier has been in operation. It is possible that the new barrier causes a delay and additional time for migrating YCT to find their way into the fish trap. We will continue to monitor run timing in the coming years.

Numerically we observed more female YCT at tributary traps than male YCT, although we could not detect a statistically significant difference in our ANOVA. In every year that we successfully trapped YCT since 2001, we observed more female YCT than males and this was true for each of the four main spawning tributaries in the South Fork. Previous research has indicated YCT repeat spawners in the South Fork are primarily female (Thurow 1982). However, female trout do not always dominate YCT populations (see Jones et al. 1992). We do not know why we observe more female fluvial cutthroat trout in the South Fork tributaries, but it may be related to males being more susceptible to angling (Irving 1955) and thus sustain higher hooking mortality rates or related to their fluvial life history strategy (Downs et al. 1997). A likely link between life-history strategy and observed sex ratios is increased spawning mortality for male YCT, as mortality has been documented to be as high as 48% for spawning YCT in streams (Welsh 1952; Ball and Cope 1961). With male YCT generally entering South Fork spawning tributaries earlier than female YCT, they may be susceptible to factors affecting mortality for a longer period of time than female YCT. Higher mortality rates for males during

YCT spawning runs could partially explain the skewed sex ratios observed in South Fork spawning tributaries, however, male YCT in Yellowstone Lake reportedly live longer than female YCT (Varley and Gresswell 1988) which suggests mortality may not be the reason for skewed sex ratios.

We could not detect a statistically significant difference in run timing between male and female YCT at any of the four main spawning tributaries of the South Fork using median tests although males arrived at tributary weirs earlier than females every year at each tributary. Male salmon and trout typically migrate to spawning areas earlier than females (Bernard and Israelsen 1982; Quinn et al. 2000), so the fact that we observe this trend at our spawning tributaries in the South Fork is not surprising. However, the difference between male and female spawning run timing was not big enough to detect a statistically significant difference, but the earlier timing of male YCT than female is consistent with previous research on cutthroat trout reports. Male YCT migrate slightly earlier than female YCT in the South Fork spawning tributaries. Biologically, however, male YCT are likely subject to more predation risks during spring spawning runs (Welsh 1952; Ball and Cope 1961) because of longer durations spent in the small tributaries.

We installed a weir and fish trap on Indian Creek in 2010 because of reports of several fluvial fish (YCT and RBT) being observed in 2009 by US Forest Service personnel. While stream flows in 2010 were conducive for trout to migrate into Indian Creek, we only observed three fluvial trout, all YCT. Indian Creek neither appears to be a major spawning tributary for YCT or a location where hybridization with non-native RBT threatens the YCT population in the South Fork.

South Fork Angler Incentive Study

The number of RBT heads turned in for the South Fork angler incentive study and thus, the number of winning fish were fewer than expected in 2010. However, the program may be increasing RBT harvest. The most recent estimate for exploitation of RBT in the South Fork is from 2009, when an estimated 13% of the population was harvested (High et al. 2011). A rough estimate of the RBT population in the South Fork, based on densities observed at Conant in 2009, was ~90,000 (IDFG unpublished data), thus a 13% exploitation rate would translate into 11,700 harvested RBT. We observed 3,048 RBT presumably harvested from the South Fork in 2010 with the angler incentive study, although we recognize that not all harvested fish were reported to IDFG. The proportion of winning fish relative to what was turned in was similar to what we expected. Based on RBT densities in 2009 (~90,000) 575 fish marked with CWTs would be 0.6% of the population. This corresponds to the actual number of observed tagged fish, 18 which was 0.6% of the 3,048 turned in. We expected more fish to be turned in which would translate into more winners based on results from the 2009 tagging study. In 2009, we marked 497 RBT with pink-colored, non-reward anchor tags and received 59 reports from anglers catching tagged fish. We marked 16% more fish in 2010 with CWTs (575 compared to 497 marked with anchor tags in 2009) but observed fewer tagged fish (18 CWT compared to 59 anchor tags). The reason for this difference is likely related to the numbers of anglers participating in the program, tag retention rates, and/or the fact that only a small percentage of the population was marked each year. The pink anchor tags in 2009 were highly visible and easily identified and reported by anglers whether the RBT were harvested or not, whereas the RBT marked with CWTs in 2010 could not be identified by anglers and only anglers who harvest RBT and turned in or “reported” marked fish. Research has indicated anglers do not always report non-reward tags, even easily identified anchor tags (Meyer et al. 2008). Thus, if the proportion of fish marked with anchor tags in 2009 and CWTs in 2010 were similar and enough anglers participated in the angler incentive study, it seems reasonable that the non-report bias for anchor tags would be balanced out by the non-harvest bias for the CWTs resulting in similar numbers of reported anchor tags and coded wire tagged RBT turned in through the Angler Incentive Study. Therefore, sample size or tag retention seem to be the most likely factors for why we had fewer winning fish in the 2010 angler incentive study than the number of reported anchor tagged RTB in 2009. This is the first time that a hand-held tagging gun has been used for resident trout of various sizes in Idaho. Tag retention rates when using a hand-held portable CWT tagging gun should be evaluated. Although we received fewer RBT and observed fewer winning fish than expected in the first year of the two-year angler incentive study, some data support the fact that RBT harvest may have increased. We expected the RBT density at Conant to once again increase similar to the increase between 2008 and 2009 because spring flows in 2009 were not conducive to limiting RBT spawning. However, while the 2010 density estimates for both YCT and BNT increased in 2010, the estimate for RBT decreased. It is possible that the number of rainbow trout submitted to IDFG for analysis is only a small portion of what is actually harvested. We will use a creel survey in 2011 to verify angler harvest.

Rainbow Trout Removal in Palisades Creek

IDFG initiated efforts to reduce hybridization risks to spawning YCT that pass upstream of the fish weir in Palisades Creek. Since 2001, IDFG has trapped migrating trout during the spring spawning run, and removed RBT to reduce hybridization rates in this YCT spawning tributary. However, RBT invaded Palisades Creek and established a resident population upstream of the fish trap as early as 1981. Thus, despite high trapping efficiencies, YCT continue to face hybridization risks upstream of our weir. Electrofishing surveys conducted by IDFG in 2002 did not find RBT upstream of Lower Palisades Lake (Meyer and Lamansky 2003). IDFG initiated this removal experiment to determine if multiple years of single-pass electrofishing could reduce introgression at the stream level. This was the first year of an ongoing experiment. Removal efforts will continue annually until enough species composition data is collected to indicate success or failure of our efforts to reduce introgression. One critical aspect of this effort is the ability of field personnel to identify RBT based on phenotype. This has proven to be a valid method to identify spawning YCT (Campbell et al. 2002). We will randomly test a sub-sample (n=30) of fish from each 0.8 km sub-section of Palisades Creek between the fish weir and Lower Palisades Lake to verify whether the species identifications determined in the field are accurate. The genetic work from samples collected in 2010 will be performed in 2011 and will be summarized in the 2011 annual report.

PIT tags

Information collected from PIT-tagged YCT indicate strong spawning tributary fidelity and some lengthy movements throughout the system, but much more rigorous analyses will be possible in the future with more recapture information. Models to estimate river-wide population abundance and population growth require multiple years of data, which may be available for YCT in the South Fork Snake River as early as 2012. Remote PIT tag detection arrays on spawning tributaries would also greatly increase our ability to assess spawning site fidelity, spawn timing, and spawning duration. With two years of PIT tag data, we are learning that PIT-tagged YCT return to the same tributaries to spawn and are moving throughout the South Fork drainage. In 2010, five YCT that were PIT-tagged in the Lorenzo monitoring reach in 2009 or 2008 spawned in Burns Creek. Furthermore, four of the previously PIT-tagged YCT captured during the 2010 population survey at Lorenzo had spawned in Burns Creek (two fish) and Pine Creek (two fish) during the spring of 2010. Upstream spawning migrations like these are typical for trout, but we also recorded downstream migrations for some PIT-tagged YCT in 2010. Of the 359 PIT-tagged YCT recaptured at the Pine Creek weir in 2010, 47% (168) were tagged upstream of the mouth of Pine Creek with some as far as the Palisades Creek boat ramp near the town of Irwin (over 26 river km away). With an overall tag loss rate of 19% recorded in 2010, tagging locations other than the body cavity should be evaluated.

Dry Bed Creel

This was the second year that a creel survey has been conducted on the Dry Bed during the snagging season, and estimates of effort, catch, and harvest were all lower in 2010 than in 2009. Water conditions are likely the main reason for the differences between the two surveys. In 2010, water flow through the Great Feeder Diversion was not completely shut off, resulting in flowing water through much of the upper Dry Bed where most of the angling effort occurs during the early part of the snagging season. With higher water levels in pools, snagging was less effective. Anglers encountering low catch rates quickly left in search of other opportunities. Overall estimates of effort, catch, and harvest were 38%, 82%, and 86% lower in 2010 than in 2009. Although these estimates were lower, it is interesting to note that Yellowstone cutthroat trout comprised 30% of the total harvest in 2010, compared to 19% in 2009. While the proportion of the catch was higher, the number of YCT harvested in 2009 (375) was still higher than the estimated number of YCT harvested in 2010 (84). However, all of these YCT represent losses from the South Fork population and do not represent the true number of YCT lost through the Great Feeder Diversion which diverts as much as half of the flows in the South Fork during the summer months and continues to divert water throughout the year (except April). The Great Feeder and other canal diversions along the South Fork potentially impact the YCT population which migrates throughout the entire South Fork Snake River corridor to complete their life cycle (High et al. 2011). The degree to which entrainment into canals negatively impacts the South Fork YCT population has not been quantified, and should be addressed in the future.

MANAGEMENT RECOMMENDATIONS

1. Continue to monitor effects of management actions on South Fork Snake River RBT, YCT and BNT populations and adjust management actions accordingly.

2. Continue to use tributary weirs to protect spawning YCT in South Fork Snake River tributaries from risks of hybridization and competition.

3. Use a creel survey in conjunction with the Angler Incentive Study to compare harvest rates of RBT with the Incentive Study to creel survey data from 2005.

4. Remove resident RBT from Palisades Creek between the fish weir and the Lower Palisades Lake for at least two more years to determine if manual removal efforts reduce introgression rates.

5. Continue marking YCT in the South Fork drainage to assess spawning stream fidelity, spawning periodicity, spawning duration, general movement patterns, and population size and growth rates using an open population model.

6. Use some other tool besides a creel survey to directly assess entrainment rates through the Great Feeder Diversion in the Dry Bed Canal.

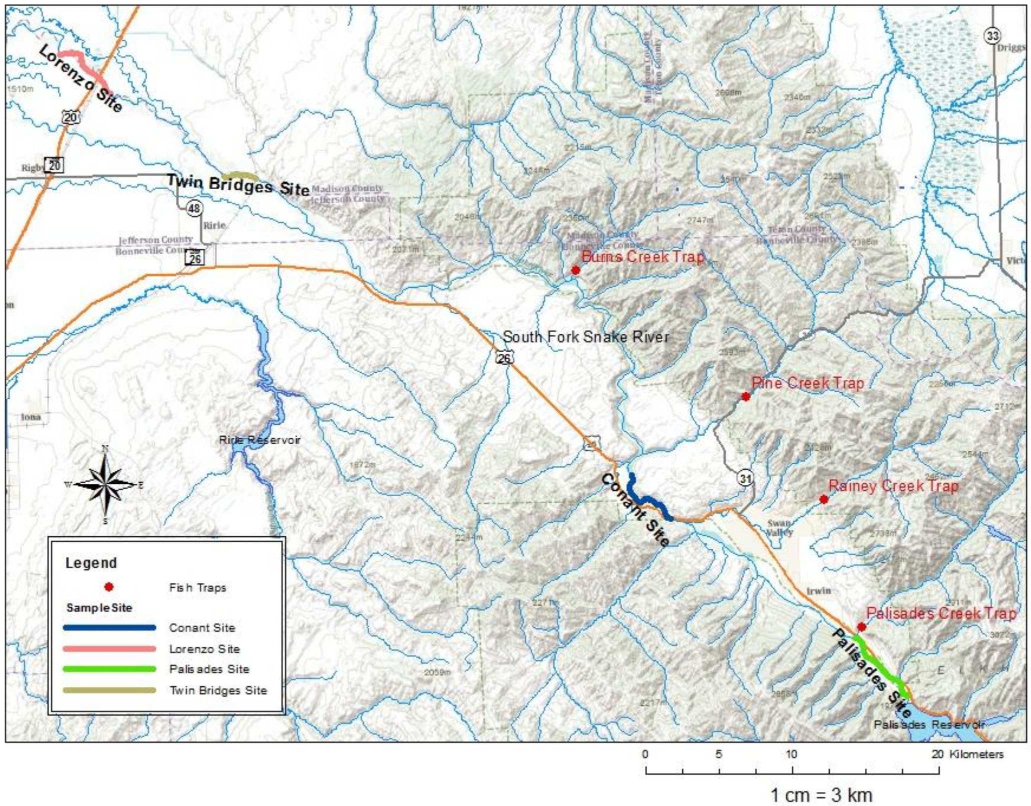

Figure 41. Locations of monitoring sites on the South Fork Snake River and weirs on tributaries.

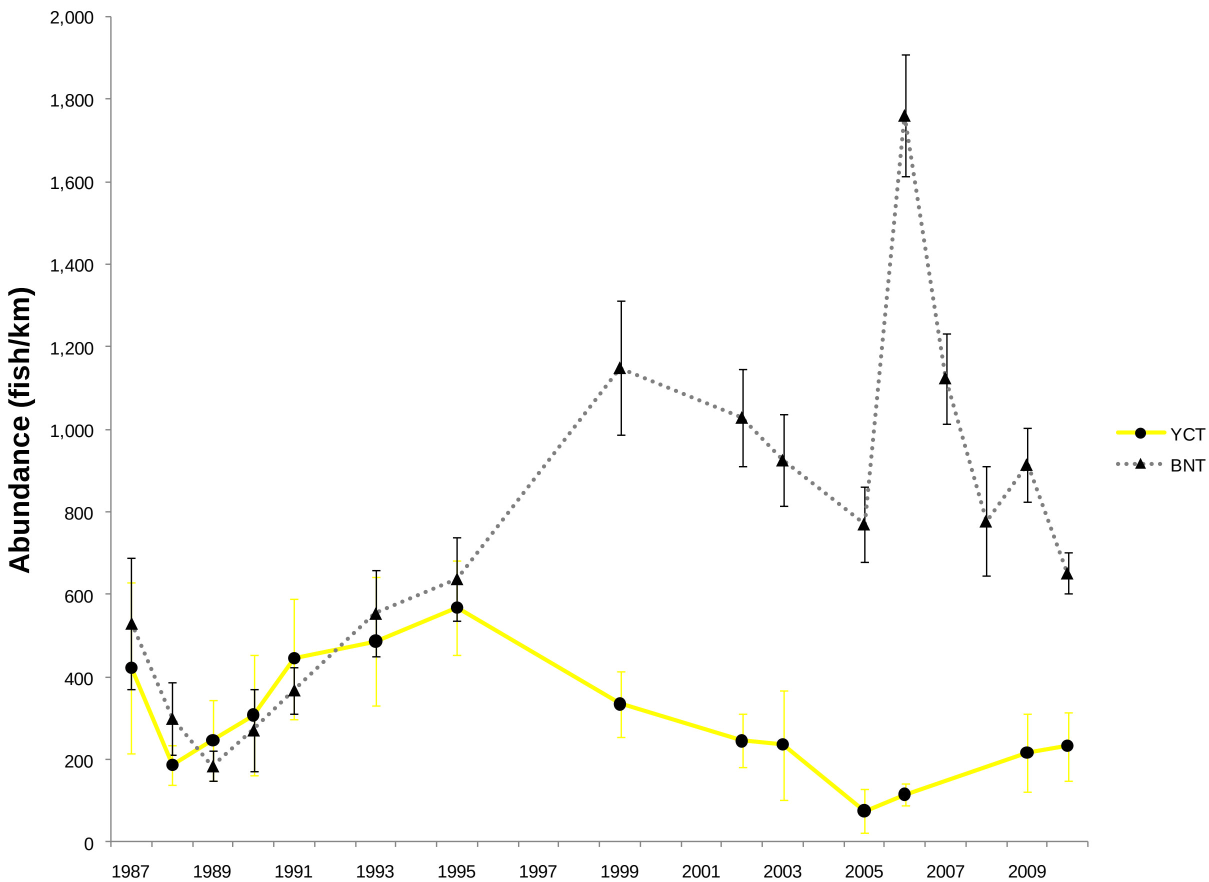

Figure 42. Estimated abundances of Yellowstone cutthroat trout (YCT) and brown trout (BNT) at the Lorenzo monitoring site on the South Fork Snake River from 1987 through 2010 with 95% confidence intervals.

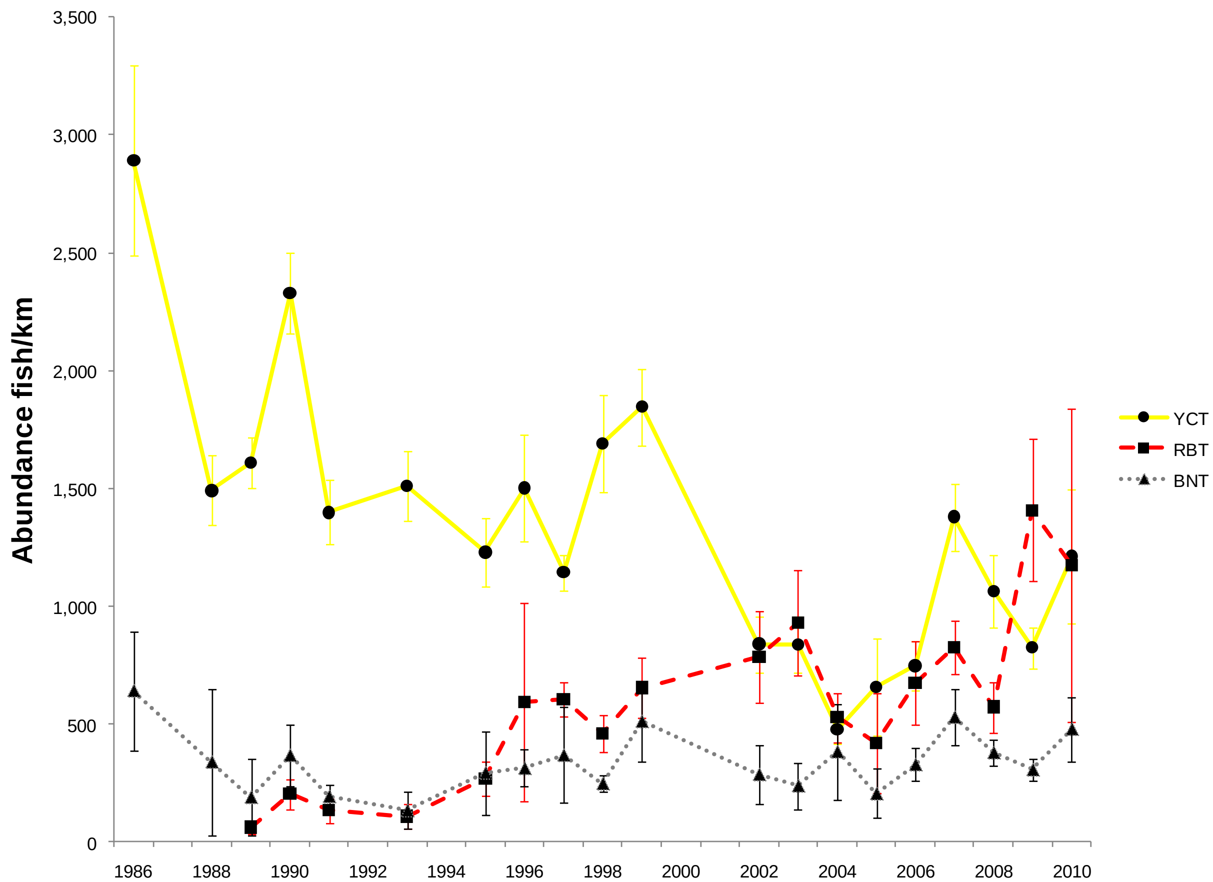

Figure 43. Estimated abundances of Yellowstone cutthroat trout (YCT), rainbow trout (RBT), and brown trout (BNT) at the Conant monitoring site on the South Fork Snake River from 1986 through 2010 with 95% confidence intervals.

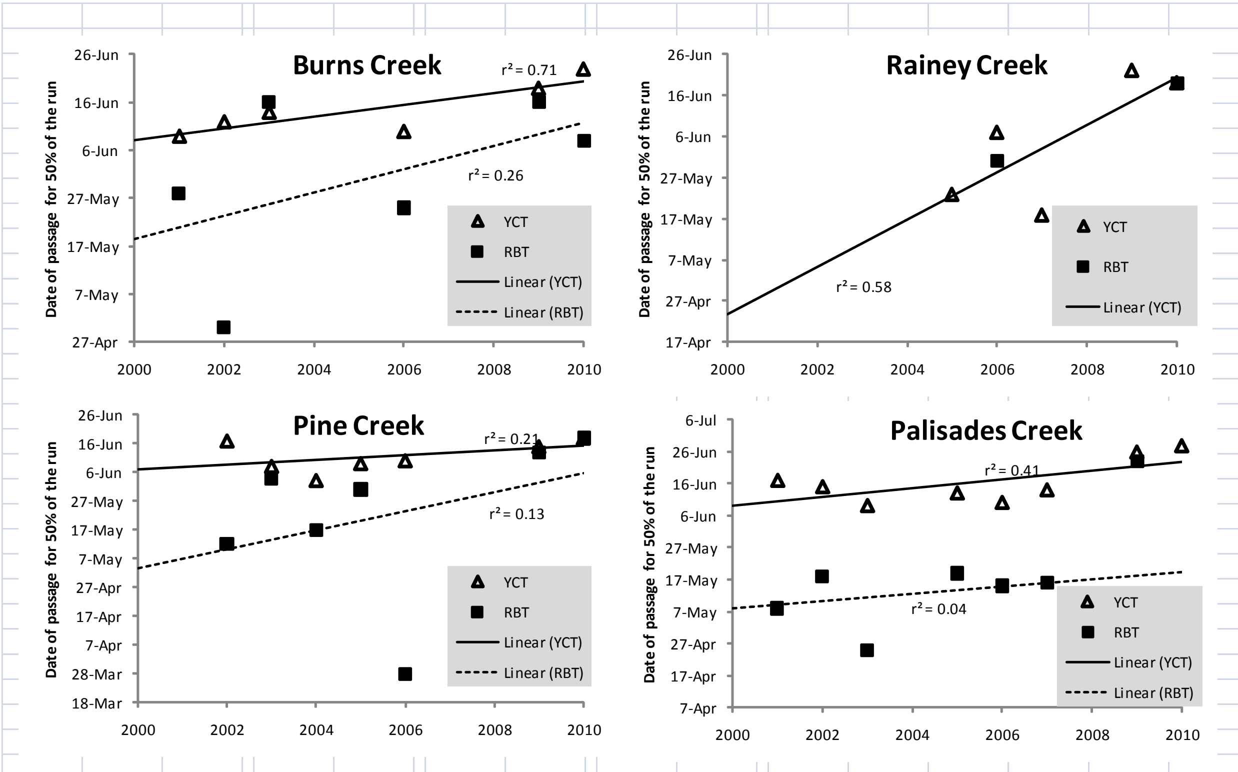

Figure 44. Dates when 50% of the spring spawning runs at Burns, Pine, Rainey, and Palisades creeks pass the fish traps between 2001 and 2010.

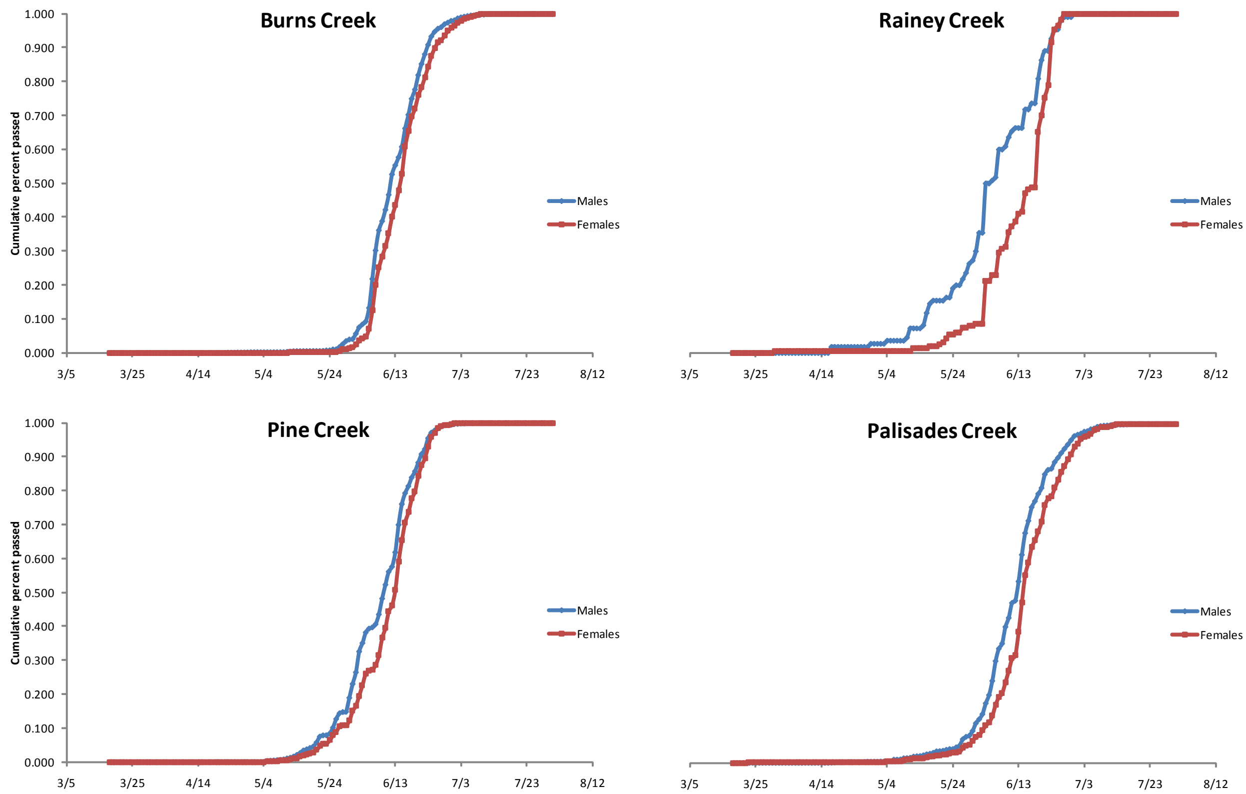

Figure 45. Average cumulative passage dates for male and female Yellowstone cutthroat trout at the Burns, Pine, Rainey, and Palisades creeks fish traps between 2001 and 2010.

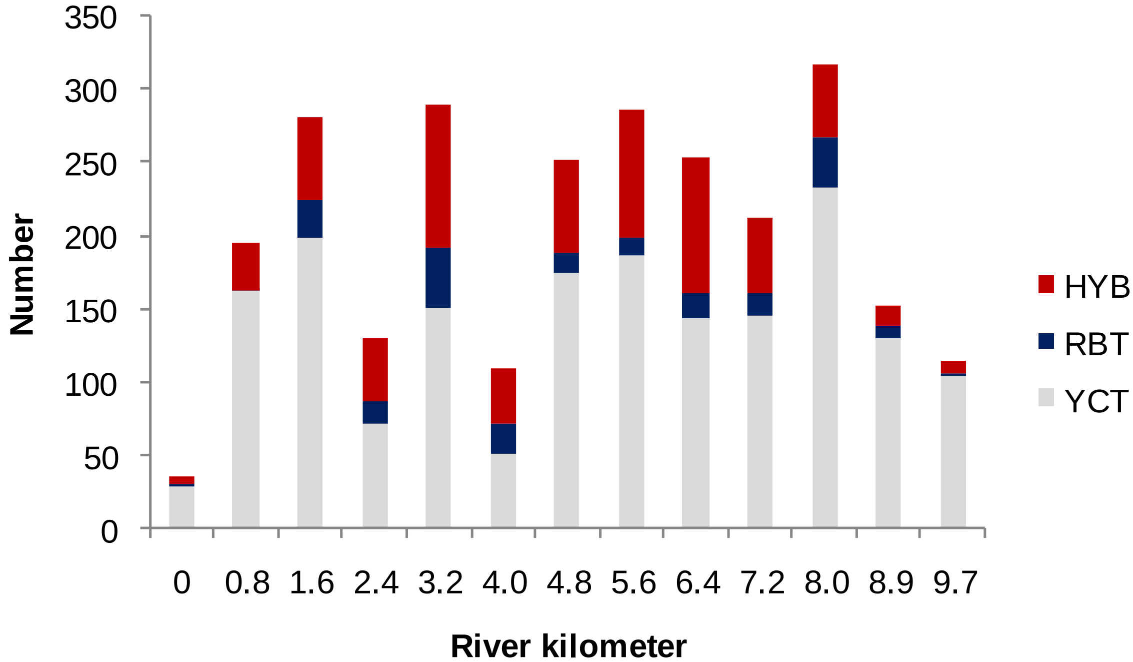

Figure 46. Number of fish captured in Palisades Creek between the fish trap near the creek's mouth and Lower Palisades Lake during a single pass electrofishing removal effort. Yellowstone cutthroat trout (YCT) were returned to the creek while rainbow trout (RBT) and rainbow x cutthroat trout hybrids (HYB) were removed.

Table 16. Summary statistics from the Lorenzo monitoring site between 1982 and 2010 on the South Fork Snake River.

	Yellowstone cutthroat trout							Rainbow trout							Brown trout							Total trout							
Year	M	C	R	R/C	YCT/Km	SD	CV	M	C	R	R/C	RBT/Km	SD	CV	M	C	R	R/C	BNT/Km	SD	CV	M	C	R	R/C	trout/Km	SD	CV	Mean Q (cms)
1987	146	63	6	9.5	422	207	0.25	2	0	0	0.0				225	102	12	11.8	531	160	0.15	380	168	18	10.7	970	99	0.10	64
1988	133	88	13	14.8	187	47	0.13	3	2	0	0.0				241	130	23	17.7	300	88	0.15	386	225	36	16.0	529	50	0.09	33
1989	119	74	13	17.6	248	98	0.20	1	2	0	0.0				199	97	22	22.7	185	38	0.10	377	204	35	17.2	677	60	0.09	25
1990	208	91	12	13.2	308	145	0.24	2	0	0	0.0				260	93	23	24.7	272	99	0.18	549	240	35	14.6	949	75	0.08	68
1991	199	175	17	9.7	445	146	0.17	0	6	0	0.0				319	234	47	20.1	369	56	0.08	560	474	64	13.5	953	67	0.07	71
1992																													
1993	144	201	18	9.0	487	155	0.16	6	8	0	0.0				238	270	27	10.0	555	105	0.10	420	531	45	8.5	1,213	74	0.06	57
1994																													
1995	264	196	22	11.2	568	116	0.10	4	5	0	0.0				325	341	41	12.0	639	101	0.08	677	731	66	9.0	1,587	73	0.05	36
1996																													
1997																													
1998																													
1999	194	163	26	16.0	335	81	0.12	3	4	0	0.0				500	588	55	9.4	1,150	161	0.07	711	798	82	10.3	1,485	74	0.05	67
2000																													
2001																													
2002	108	138	14	10.1	246	65	0.13	4	3	1	33.3				457	579	61	10.5	1,030	117	0.06	582	750	76	10.1	1,385	66	0.05	98
2003	90	81	11	13.6	237	133	0.29	2	2	0	0.0				557	432	61	14.1	926	110	0.06	668	593	72	12.1	1,184	61	0.05	81
2004																													
2005	37	47	4	8.5	76	54	0.36	5	2	0	0.0				440	486	67	13.8	771	91	0.06	641	569	71	12.5	2,030	96	0.05	78
2006	112	71	14	19.7	116	25	0.11	10	12	1	8.3				1154	933	140	15.0	1,761	148	0.04	1,326	1,064	155	14.6	2,116	77	0.04	
2007	90	41	2	4.9				17	6	0	0.0				764	446	67	15.0	1,125	110	0.05	888	525	69	13.1	1,504	70	0.05	131
2008	30	34	0	0.0				2	2	0	0.0				373	365	40	11.0	778	132	0.09	415	418	40	9.6	988	77	0.08	157
2009	77	110	10	9.1	218	93	0.22	13	10	1	10.0				603	739	104	14.1	915	90	0.05	718	916	117	12.8	1,236	53	0.04	92
2010	110	91	10	11.0	233	83	0.18	8	11	1	9.1				600	545	110	20.2	653	49	0.04	735	790	121	15.3	956	34	0.04	91

Table 17. Summary statistics from the Conant monitoring site between 1987 and 2010 on the South Fork Snake River.

	Yellowstone cutthroat trout							Rainbow trout							Brown trout							Total trout							
Year	M	C	R	R/C	YCT/Km	SD	CV	M	C	R	R/C	RBT/Km	SD	CV	M	C	R	R/C	BNT/Km	SD	CV	M	C	R	R/C	trout/Km	SD	CV	Mean Q (cms)
1982					1,899							16							256										
1983																													
1984																													
1985																													
1986	1,170	546	70	12.8	2,890	402	0.07	32	16	2	12.5				183	105	8	7.6	1,034	408	0.20	1,385	667	80	0.12	2,351	236	0.10	102
1987	281							5							26							312							26
1988	1,100	561	98	17.5	1,491	148	0.05	41	18	1	5.6				113	46	4	8.7	548	500	0.47	1,254	625	103	0.16	1,836	88	0.05	103
1989	1,416	1,050	200	19.0	1,610	108	0.03	57	55	10	18.2	102	42	0.21	92	76	11	14.5	308	261	0.43	1,565	1,181	221	0.19	1,791	54	0.03	86
1990	1,733	1,522	317	20.8	2,330	173	0.04	113	109	14	12.8	330	104	0.16	173	117	12	10.3	594	214	0.18	2,019	1,748	343	0.20	2,984	89	0.03	101
1991	1,145	625	140	22.4	1,399	136	0.05	98	54	9	16.7	216	87	0.20	150	119	19	16.0	314	83	0.14	1,393	798	168	0.21	1,616	58	0.04	132
1992	595							34							76							705							60
1993	972	623	100	16.1	1,512	150	0.05	74	41	6	14.6	177	82	0.24	101	64	10	15.6	218	125	0.29	1,147	728	116	0.16	1,643	66	0.04	91
1994	853							87							110							1,050							52
1995	631	542	77	14.2	1,230	147	0.06	130	140	17	12.1	436	116	0.14	150	108	13	12.0	474	284	0.31	911	790	107	0.14	1,696	79	0.05	93
1996	707	548	72	13.1	1,502	225	0.08	155	111	5	4.5	958	677	0.36	212	124	18	14.5	506	126	0.13	1,074	783	95	0.12	2,292	131	0.06	107
1997	910	895	164	18.3	1,145	76	0.03	429	467	72	15.4	974	118	0.06	344	281	82	29.2	595	327	0.28	1,683	1,643	318	0.19	1,969	48	0.02	85
1998	674	682	61	8.9	1,691	204	0.06	216	247	26	10.5	743	127	0.09	257	216	49	22.7	401	58	0.07	1,147	1,145	136	0.12	2,191	79	0.04	110
1999	1,019	883	117	13.3	1,847	163	0.04	345	241	29	12.0	1,055	204	0.10	293	241	31	12.9	825	273	0.17	1,657	1,365	177	0.13	2,827	90	0.03	110
2000	797							260							133							1,190							91
2001	776							321							208							1,305							117
2002	495	394	50	12.7	841	119	0.07	295	257	24	9.3	1,265	314	0.13	111	104	9	8.7	463	197	0.22	901	755	83	0.11	1,803	81	0.05	72
2003	422	571	72	12.6	840	119	0.07	272	360	29	8.1	1,501	364	0.12	143	165	27	16.4	386	160	0.21	837	1,096	128	0.12	1,821	67	0.04	108
2004	315	379	51	13.5	478	61	0.07	227	304	29	9.5	854	168	0.10	169	202	22	10.9	618	328	0.27	711	885	102	0.12	1,441	62	0.04	114
2005	391	254	30	11.8	658	205	0.16	172	142	11	7.7	678	340	0.26	115	95	10	10.5	333	169	0.26	678	491	51	0.10	1,588	200	0.13	106
2006	423	365	54	14.8	749	104	0.07	289	251	23	9.2	1,092	287	0.13	215	223	31	13.9	531	113	0.11	927	839	108	0.13	1,938	80	0.04	
2007	784	568	72	12.7	1,380	142	0.05	565	361	52	14.4	1,329	182	0.07	404	289	50	17.3	854	189	0.11	1,753	1,218	174	0.14	2,713	87	0.03	116
2008	377	554	51	9.2	1,065	156	0.07	187	318	25	7.9	925	174	0.10	205	253	29	11.5	612	92	0.08	769	1,125	105	0.09	1,882	74	0.04	170
2009	623	489	90	18.4	826	87	0.05	475	425	34	8.0	2,270	486	0.11	261	219	42	19.2	495	77	0.08	1,359	1,133	166	0.15	2,276	80	0.04	98
2010	389	307	27	8.8	1,211	284	0.12	286	139	7	5.0	1,893	1,073	0.29	178	154	14	9.1	772	220	0.15	853	600	48	0.08	2,295	297	0.13	127

Table 18. Summary tributary fish trap operation dates, efficiencies and catches from 2001 through 2010.

Location and year	Weir type	Operation dates	Estimated weir efficiency (%)[a]	Catch: Cutthroat trout	Catch: Rainbow trout	Catch: Total
Burns Creek						
2001[b]	Floating panel	March 7 - July 20	16	3,156	3	3,159
2002[b]	Floating panel	March 23 - Jul 5	NE[c]	1,898	46	1,944
2003[d]	Floating panel	March 28 - June 23	17-36	1,350	1	1,351
2004	ND[e]	ND	ND	ND	ND	ND
2005	ND	ND	ND	ND	ND	ND
2006	Mitsubishi	April 14 - June 30	NE	1,539		
2007	ND	ND	ND	ND	ND	ND
2008	ND	ND	ND	ND	ND	ND
2009	Fall/velocity	Apirl 9 - July 22	98	1,491	2	1,493
2010	Fall/velocity	March 26 - July 14	100	1,550	2	1,552
Pine Creek						
2001[b]	ND	ND	ND	ND	ND	ND
2002[b]	Floating panel	April 2 - July 5	NE	202	14	216
2003[f]	Floating panel	March 27 - June 12	40	328	7	335
2004	Hard picket	March 25 - June 28	98	2,143	27	2,170
2005	Hard picket	April 6 - June 30	NE	2,817	40	2,857
2006[g]	Mitsubishi	April 14 - April 18	ND	ND	ND	ND
2007	Mitsubishi	March 24 - June 30	20	481	2	483
2008	Hard picket	April 21 - July 8	NE	115	0	115
2009	Hard picket	Apirl 6 - July 15	49	1,356	1	1,357
2010	Electric	April 13 - July 6	NE	2,972	3	2,975
Rainey Creek						
2001[b]	Floating panel	March 7 - July 6	NE	0	0	0
2002[b]	Floating panel	March 26 - June 27	NE	1	0	1
2003	ND	ND	ND	ND	ND	ND
2004	ND	ND	ND	ND	ND	ND
2005	Hard picket	April 7 - June 29	NE	25	0	25
2006	Hard picket	April 5 - June 30	NE	69	3	72
2007	Hard picket	March 19 - June 30	NE	14	0	14
2008	Hard picket	June 19 - July 11	NE	14	0	14
2009	Hard picket	April 7 - July 6	NE	23	0	23
2010	Hard picket	April 13 - June 29	NE	145	1	146
Palisades Creek						
2001[b]	Floating panel	March 7 - July 20	10	491	160	651
2002[b]	Floating panel	March 22 - July 7	NE	967	310	1,277
2003	Floating panel	March 24 - June 24	21 - 47	529	181	710
2004	ND	ND	ND	ND	ND	ND
2005	Mitsubishi	March 18 - June 30	91	1,071	301	1,372
2006	Mitsubishi	April 4 - June 30	13	336	52	388
2007	Electric	May 1 - July 28	98	737	20	757
2008	ND	ND	ND	ND	ND	ND
2009	Electric	May 12 - July 20	26	202	4	206
2010	Electric	March 19 - July 18	86	545	50	595
Total by year						
2001				3,647	163	3,810
2002				3,068	370	3,438
2003				2,207	189	2,396
2004				2,143	27	2,170
2005				3,913	341	4,254
2006				1,944	55	460
2007				1,232	22	1,254
2008				129	0	129
2009				3,072	7	3,079
2010				5,212	56	5,268
Grand Total				21,355	1,174	20,990

[a]Weir efficiency was estimated using several different methods

[b]From Host (2003)

[c]NE = no estimate

[d]Weir was shut down on June 10, but the trap was operated until June 23

[e]ND = no dat; weir either not built or not operated

[f]Weir was shut down early due to high cutthroat trout mortality

[g]Weir was destroyed during high runoff

Table 19. Summary of locations of Yellowstone cutthroat trout PIT-tagging and recapture locations in 2010. The number in parentheses indicates the number of recaptured cutthroat trout that were originally PIT tagged a previous year (2009 or 2008).

			Stream location when originally tagged						
Stream location	# Marked	# Recaptured	Burns Cr Weir	Pine Cr Weir	Rainey Cr Weir	Palisades Cr Weir or Screenyard	Conant Monitoring Site	Lorenzo Monitoring Site	Main River Winter Electroshocking
Burns Creek Weir	581	215	194 (72)	0	0	0	3	5	13 (From Dry Canyon to Burns Cr)
Pine Creek Weir	1,259	359	0	121 (51)	0	0	121	0	117 (From Palisades Cr to Burns Cr)
Rainey Creek Weir	131	6	0	0	2 (1)	0	3	0	1 (At Blacks Canyon)
Palisades Creek Weir and screenyard trap	539	146	0	0	0	89 (29)	24	0	33 (From Palisades Cr to Lufkin Bottom)
Indian Creek Weir	2	0	-	-	-	-	-	-	-
Lorenzo Fall Monitoring Site	177	25	2	2	0	0	0	21 (12)	0
Conant Fall Monitoring Site	550	155	2	13	0	1	136 (109)	0	3 (From Conant to Dry Canyon)
Main River Electrofishing (Angler Incentive Study winter marking)	645	64	6	7	0	5	25	0	21 (From Palisades Cr to Rattlesnake Point)
Total	**3,884**	**970**	**204**	**143**	**2**	**95**	**312**	**26**	**188**

<u>HENRYS FORK</u>

ABSTRACT

We used boat mounted electrofishing equipment to assess fish populations in the Box Canyon, Riverside, Stone Bridge, and St. Anthony reaches of the Henrys Fork Snake River during 2010. In Box Canyon, we estimated rainbow trout *Oncorhynchus mykiss* density at 2,254 fish/km, at increase of nearly 66% from the 2009 estimate, and an increase of 25% above the 15 year average (1,803 fish/km). Size indices (proportional stock density [PSD] and relative stock density [RSD-400]) indicate that the population is well balanced (79 and 27, respectively).

The rainbow trout population in the Riverside reach, estimated at 3,515 fish per km, appears similar to the only previous sample conducted in 1987. This reach was dominated by juvenile fish (mean total length: 225 mm, PSD: 23, RSD-400: 4), indicating that it may be a rearing area for fish produced in upstream reaches or tributaries.

We estimated 1,605 trout per km in the Stone Bridge reach of the Henrys Fork, which is not significantly different than the estimates conducted in 2002 and 2003. During 2010, rainbow trout comprised 85% of the total trout captured while brown trout *Salmo trutta* comprised the additional 15%. This has shifted slightly since the 2002 and 2003 surveys, when rainbow trout and brown comprised approximately 91% and 9% of the total trout captured, respectively.

We surveyed the St. Anthony reach during the spring and fall of 2010 and observed significant differences in trout density between seasons. Differences were first observed in 2009, when rainbow trout and brown trout populations had significantly increased since our prior estimate conducted in 2004. Differences in the timing of the 2009 and 2004 sampling led us to question the validity of comparing the two samples, prompting the spring and fall samples conducted in 2010. During 2010, average trout densities doubled from spring to fall, possibly due to changing habitat conditions downstream of this reach, causing immigration into the St. Anthony sample reach.

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INTRODUCTION

The Henrys Fork Snake River attracts anglers from throughout the nation. An economic survey conducted in 2004 estimated that anglers spent nearly 170,000 angler days in the Henrys Fork drainage from May through September, and that the fishery generated nearly $30 million to the local economy. Similarly, an IDFG economic survey in 2003 showed that Fremont County, which encompasses most of the Henrys Fork drainage, ranked first out of the 44 counties in Idaho in terms of angler spending. This study, which calculated effort for the entire year, estimated that anglers fished nearly 225,000 days in the Henrys Fork drainage and spent nearly $51 million during angling trips.

The Henrys Fork Snake River forms at the confluence of Big Springs Creek and the Henrys Lake outlet, and flows approximately 25 km before reaching Island Park Dam. Below Island Park Dam, the Henrys Fork flows approximately 147 km before joining the South Fork Snake River to form the Snake River. The Henrys Fork above Island Park Reservoir provides a yield fishery primarily supported by stocked hatchery catchable rainbow trout *Oncorhynchus mykiss* and fingerling Yellowstone cutthroat trout *O. clarkii bouvieri*. Management of the Henrys Fork from the mouth upstream to Island Park Dam emphasizes wild, natural populations without hatchery supplementation. The Henrys Fork Snake River below Island Park Dam, particularly the Box Canyon and Harriman Ranch sections, support a world famous wild rainbow trout fishery.

Previous research has emphasized the importance of winter river flows to the survival of age-0 rainbow trout in the Box Canyon reach (Garren et al. 2006a, Mitro 1999). Higher winter flows in this reach results in significantly higher overwinter survival of juvenile trout and subsequent recruitment to the fishery below Island Park Reservoir. Implementation of a congressionally mandated Drought Management Plan has improved communications and planning regarding winter discharges. We will continue to work cooperatively with stakeholders to maximize wild trout survival, based on timing and magnitude of winter releases from Island Park Dam.

STUDY SITE

During 2010, we sampled the Box Canyon, Riverside, Stone Bridge, and St. Anthony reaches of the Henrys Fork Snake River (Figure 47). The Box Canyon reach is sampled on an annual basis as part of our long term monitoring program for the Henrys Fork Snake River. The Box Canyon reach started below Island Park Dam at the confluence with the Buffalo River and extended downstream 3.7 km to the bottom of a large pool.

The Riverside reach began 2.5 km downstream of the boat ramp and extended for 5.1 km, ending 0.5 km above the Hatchery Ford boat ramp. The Riverside reach has only been sampled once prior to 2010, by Idaho State University in 1987.

The Stone Bridge reach started 3.0 km downstream of the boat ramp and continued 4.6 km downstream, ending at the pilings from an old bridge crossing. The Stone Bridge reach was most recently sampled in 2003 and 2002; prior to that, this reach was sampled in 1988, 1990, and 1997.

The St. Anthony reach started just below the Consolidated Farmers Canal (approximately 4km downstream of St. Anthony) and extended downstream 7 km, ending just above the Parker-Salem Bridge. The St. Anthony reach was previously sampled in the fall of 2009 and spring of 2004. Coordinates for all mark-recapture transect boundaries are presented in Appendix A.

OBJECTIVES

To obtain current information on fish population characteristics for fishery management decisions on the Henrys Fork Snake River, and to develop appropriate management recommendations.

1. Estimate abundance and size structure of wild trout populations in the Box Canyon, Riverside, Stone Bridge, and St. Anthony reaches of the Henrys Fork Snake River.

METHODS

During 2010, we altered our electrofishing methods from previous surveys in an attempt to improve efficiency. Historically, we have used two drift boat mounted electrofishing units to sample fish populations throughout the Henrys Fork Snake River. In 2010, we attempted to use three electrofishing boats (two drift boats, one raft) to improve our sampling efficiency and increase the precision of our estimates in the Box Canyon reach. We marked fish on May 17 and 18 followed by a seven day rest and two days of recapture (May 25-26). Two passes per boat were made on each marking and recapture day. Equipment failure prohibited the use of three boats on our first day of marking (May 17); therefore, we used two boats on the first marking day and three boats on all subsequent days.

In the Riverside reach, we marked fish on three days (June 6-8), followed by three days of recapture (June 14-16). One pass was completed by both rafts on each marking and recapture day.

In the Stone Bridge reach, we marked fish using a single pass with both drift boats on May 5 and recaptured fish with a single pass with both boats on May 12.

The St. Anthony reach was surveyed during May and again in October, using a single pass from two electrofishing rafts for marking following by a single pass recapture day. During the spring, fish were marked on May 4 and recaptured on May 11; during the fall, fish were marked on October 5 and recaptured on October 12. The St. Anthony reach was surveyed twice to document seasonal differences in trout abundance observed in previous surveys. All trout encountered were collected, identified, measured for total length, and those exceeding 150 mm were marked with a hole punch in the caudal fin prior to release. Fish were not marked on the recapture date, but all fish previously marked were recorded as such.

In all reaches, we estimated densities for all trout > 150 mm using the Log-likelihood method in MR5 software (MR5; Montana Department of Fish, Wildlife, and Parks 1997). Proportional stock densities (PSD) were calculated as the number of individuals (by species) ≥ 300 mm / by the number ≥ 200 mm. Similarly, relative stock densities of fish greater than 400 mm and 500 mm (RSD-400, RSD-500) were calculated using the same formula, with the numerator replaced by the number of fish > 400 mm and > 500 mm (Anderson and Neumann 1996).

We used linear regression to examine the relationship between age-2 rainbow trout abundance and winter stream flow (cubic feet per second [cfs]) in the Box Canyon reach of the Henrys Fork Snake River, as described by Garren et al (2006a). We log-transformed age-2 rainbow trout abundance and mean winter flow data from the past 13 surveys to establish the following relationship:

$$\log_{10} \text{age-2 rainbow trout abundance} = 0.5225 \log_{10} \text{winter stream flow} + 2.1347$$

Using this equation we predicted the expected abundance of age-2 rainbow trout based on mean winter stream flows observed during 2009 (December 2008 - February 2009). To validate this relationship, we determined age-2 rainbow trout abundance during the 2010 electrofishing surveys by estimating the number of fish between 230 and 329 mm, which correlates to the lengths of age-2 trout in past surveys. Age-2 rainbow trout were determined to be the first year class fully recruited to the electrofishing gear (Garren 2006b). We then compared predicted and observed age-2 rainbow trout abundance in Box Canyon to evaluate the ability of the equation above to predict year class strength based on winter flow. Data from 2010 was added to this regression model and will be used to predict future year class strength based on mean winter stream flows.

RESULTS

Box Canyon

We collected 2,990 trout during four days of electrofishing in the Box Canyon. Species composition of trout collected was 99% rainbow trout and 1% brook trout. Rainbow trout ranged in size from 75 mm to 527 mm, with a mean and median total length of 307 mm and 288 mm, respectively (Figure 48; Appendix F). Rainbow trout PSD, RSD-400, and RSD-500 were 51, 23, and 1, respectively (Table 20). We used the Log-likelihood Method (LLM) to estimate 8,341 rainbow trout >150 mm (95% CI = 7,857 – 8,825, cv = 0.03, Table 21, Appendix G) in the reach, which equates to 2,254 fish per km (Figure 49). Our efficiency rate (ratio of recaptured fish marked during the marking runs [R] to total fish captured on the recapture run [C]), unadjusted for size selectivity was 20% (Appendix G). Based on mean winter stream flows for 2009 (325 cfs), the regression model estimated an abundance of 2,800 age-2 rainbow trout in the 2010 survey. Based on the length-specific estimates of abundance our Log Likelihood model calculates, we estimated actual age-2 rainbow trout abundance at 3,974 fish in the Box Canyon during 2010 (Figure 50). We incorporated the data from 2010 into the model to help improve the effectiveness and utility of this tool. Utilizing all available sampling and stream flow data from 1995 through 2010, the model demonstrates the significant relationship between mean winter stream flow and age-2 rainbow trout abundance (r^2=0.51, n=14, P=0.0044).

Riverside to Hatchery Ford

We collected 1,847 rainbow trout during six days of electrofishing in the Riverside reach of the Henrys Fork. Species composition of trout collected was 99% rainbow trout and 1% brook trout. Rainbow trout ranged between 80 mm and 595 mm (Figure 51), with a mean and median total length of 225 mm and 209 mm, respectively (Table 20). Rainbow trout PSD, RSD-400, and RSD-500 values were 23, 4, and 1, respectively (Table 20). We estimated 18,138 rainbow trout >150 mm for the reach (95% CI = 15,106 – 21,170; cv = 0.09) (Table 21), which equates to 3,515 rainbow trout per km (Figure 52). Our efficiency rate (unadjusted for size selectivity) was 5%.

Stone Bridge to Ashton

We collected 784 trout over two days of electrofishing in the Stone Bridge reach of the Henrys Fork Snake River. Species composition of trout collected was 85% rainbow trout and 15% brown trout. Our efficiency rate (unadjusted for size selectivity) was 5%. Rainbow trout ranged in size from 106 mm to 484 mm (Figure 53), with a mean and median total length of 317 mm (Table 20). Rainbow trout PSD, RSD-400, and RSD-500 were 58, 15, and 0, respectively (Table 20). Brown trout ranged between 134 mm and 555 mm (Figure 53), with a mean and median total length of 389 mm and 405 mm, respectively (Table 20). Brown trout PSD, RSD-400, and RSD-500 were 87, 57, and 7, respectively. We used the Log-likelihood method to estimate 7,384 trout >150 mm (95% CI = 5,956 – 8,812, cv = 0.10) in the reach, which based on percentage of species composition, equates to 6,276 rainbow trout (1,364 per km) and 1,108 brown trout (241 per km) (Figure 54).

St. Anthony Railroad to Parker-Salem Bridge

We collected 348 trout over two days of electrofishing during our spring surveys of the St. Anthony reach of the Henrys Fork Snake River. Species composition of trout collected was 85% brown trout, 15% rainbow trout and <1% Yellowstone cutthroat trout Our efficiency rate (unadjusted for size selectivity) was 13%. Brown trout ranged between 109 mm and 689 mm (Figure 55a), with a mean and median total length of 347 mm and 367 mm, respectively (Table 20). Rainbow trout ranged in size from 211 mm to 550 mm (Figure 55a), with a mean and median total length of 345 mm and 356 mm, respectively (Table 20). Rainbow trout PSD, RSD-400, and RSD-500 were 65, 35, and 2, respectively, while brown trout were 66, 32, and 1, respectively. Due to a low number of rainbow trout recaptures (n=2), we combined mark-recapture data for brown trout and rainbow trout to obtain a Log-likelihood population estimate and partitioned the estimate based on the percent species composition observed during electrofishing. We estimated 1,693 trout >150 mm for the reach (95% CI = 1,283 – 2,103; cv = 0.12), which equates to 242 trout per km (brown trout: 206/km; rainbow trout: 36/km) (Figure 56).

We collected 831 trout over two days of electrofishing during our fall surveys of the St. Anthony reach of the Henrys Fork Snake River. Species composition of trout collected was 86% brown trout and 14% rainbow trout. Our efficiency rate (unadjusted for size selectivity) was 8%. Brown trout ranged between 83 mm and 610 mm (Figure 55b), with a mean and median total length of 322 mm and 315 mm, respectively (Table 20). Rainbow trout ranged in size from 78 mm to 513 mm (Figure 55b), with a mean and median total length of 360 mm and 375 mm, respectively. Rainbow trout PSD, RSD-400, and RSD-500 were 81, 36, and 2, respectively. Brown trout PSD, RSD-400, and RSD-500 were 56, 26, and 5, respectively. We estimated 4,277 trout >150 mm for the reach (95% CI = 3,601 – 4,953; cv = 0.08), which equates to 611 trout per km (brown trout: 528/km; rainbow trout: 83/km) (Figure 56).

DISCUSSION

Estimates of rainbow trout abundance in the Box Canyon show an increase of 66% when compared to 2009 and an increase of 25% over the long term average. Increases in the overall population can be directly linked to the age-2 portion of the population, and as expected, has resulted in a smaller average size and lower than average stock density indices, but should result in good fishing opportunities for the upcoming seasons.

Age-2 rainbow trout abundance continues to be significantly related to mean winter stream flow within the Box Canyon, as demonstrated by Mitro (1999) and Garren et al. (2006a), although observed age-2 abundance was much higher than predicted in 2010. The regression model between winter stream flow and age-2 rainbow trout abundance predicted 2,800 age-2 rainbow trout during 2010; the electrofishing survey yielded an estimated 3,974 age-2 rainbow trout, indicating that other factors may also be influencing overwinter survival in Henrys Fork. The construction of a fish ladder at the mouth of the Buffalo River in 2005 has allowed passage between the Henrys Fork and the Buffalo River, and may be providing increased wintering habitat for juvenile rainbow trout and/or spawning habitat for migratory adults, thus increasing recruitment into the Box Canyon. This model will continue to be used to predict age-2 rainbow trout abundance and will be updated with future sampling results. Stream flows during the winter of 2010 averaged 387 cfs, indicating that a relatively strong year class of age-2 rainbow trout (over 3,000) should be observed in 2011.

Modifications to the sampling methods during 2010 (three shocking boats vs. two) should be continued when possible. With the addition of a third boat, we handled more individual fish than during any other survey on record. While this may be related to a higher abundance of fish present, the coefficient of variation of our population estimate was also the lowest of all estimates conducted in Box Canyon (Appendix G). Utilizing three electrofishing boats in the future will allow us to handle more fish with a similar amount of effort as in previous samples, thus increasing the efficiency of our sampling and improving the precision of our population estimates in the Box Canyon.

The trout population in the Riverside reach of the Henrys Fork appears similar to what was observed in the only other survey of this reach, conducted in 1987. Although the density estimated by Angradi and Contor (1989) was slightly higher, it was not significantly different, while the number of fish handled and the size structure was nearly identical. This high gradient reach likely provides rearing habitat for juvenile fish produced in upstream reaches or tributaries. Mitro (1999) documented juvenile rainbow trout migrating downstream from the Box Canyon and Harriman Ranch reaches of the Henrys Fork into the Riverside reach for overwintering. Potential future studies on movement, migration, and habitat use of various life stages of rainbow trout should focus on the relationship between these distinct river segments, and include the entire upper river (from Mesa Falls to Island Park Dam) and its tributaries..

Overall, the trout population in the Stone Bridge reach of the Henrys Fork has remained stable since surveys conducted in 2002 and 2003. There were no statistical differences in estimates from 2002, 2003, and 2010, although the 2003 estimate appears much higher. The 2003 population estimate was likely inflated due to a low number of recaptures (n =3), resulting in a coefficient of variation of 38%, suggesting that this estimate is relatively imprecise (Pollock et al. 1990). Similar to other recent surveys of the lower Henrys Fork (reaches below Mesa Falls), while overall trout numbers have remained stable, we have observed shifts in species composition (High et al. 2011). Rainbow trout comprised 92% of the species composition in 2002 but decreased to 85% in 2010, while brown trout have nearly doubled, increasing from 8% to 15%. This trend is similar to what has been observed in the Vernon, Chester, and St. Anthony reaches of the Henrys Fork. While brown trout density is relatively low in the Stone Bridge reach (241/km), it consistently produces large brown trout, as evidenced by the RSD-500 value of 7 observed in 2010.

Survey results in the St. Anthony reach of the Henrys Fork continue to demonstrate seasonal variation in trout abundance. This was first observed in 2009, when we documented a 400% increase in trout abundance from the previous survey conducted in 2004 (High et al.

2011). Differences in sampling time (spring 2004 vs. fall 2009) prompted us to conduct a spring and fall survey during 2010 in an attempt to document seasonal differences in trout abundance. In 2010 we observed trends similar to what was seen between the fall 2009 and spring 2004 surveys, with trout abundance (brown trout and rainbow trout) being lowest during spring and increasing in the fall. As noted in High et al. (2011), based on observations of length frequencies, it did not appear that the increase in abundance in the fall estimate was related to an influx of migratory spawning brown trout. During the fall of 2010, we observed an overall increase in brown trout, but particularly those under 300 mm, compared to our spring survey. We observed a similar pattern when comparing the fall 2009 estimate to the spring 2004 estimate. The seasonal fluctuations in trout density may be related to changing habitat conditions, particularly downstream of the St. Anthony sample reach, where water temperatures likely increase during summer. Conditions in this area, and as far downstream as the confluence with the South Fork Snake River, may be suitable throughout the winter and spring, but may become unfavorable as summer progresses, causing movement upstream towards St. Anthony throughout the summer and early fall.

MANAGEMENT RECOMMENDATIONS

1. Continue annual population surveys in the Box Canyon to quantify population response to changes in the flow regime over time.

2. Work with the irrigation community and other agencies to obtain increased winter flows to benefit trout recruitment.

3. Continue modified sampling methods (three shocking boats/rafts) in the Box Canyon to determine improvements in capture efficiency and adapt to other sampling reaches where applicable.

4. Incorporate the Riverside reach into the population estimate sample site schedule (every 3 – 4 years).

5. Investigate the relationship between upper river reaches and tributaries, particularly the contributions to the Harriman Ranch reach from the Box Canyon and Riverside reaches, as well as Fish Creek, Thurmon Creek, and the Buffalo River.

Figure 47. Map of the Henrys Fork Snake River watershed and electrofishing sample sites (Box Canyon, Riverside, Stone Bridge, and St. Anthony) during 2010.

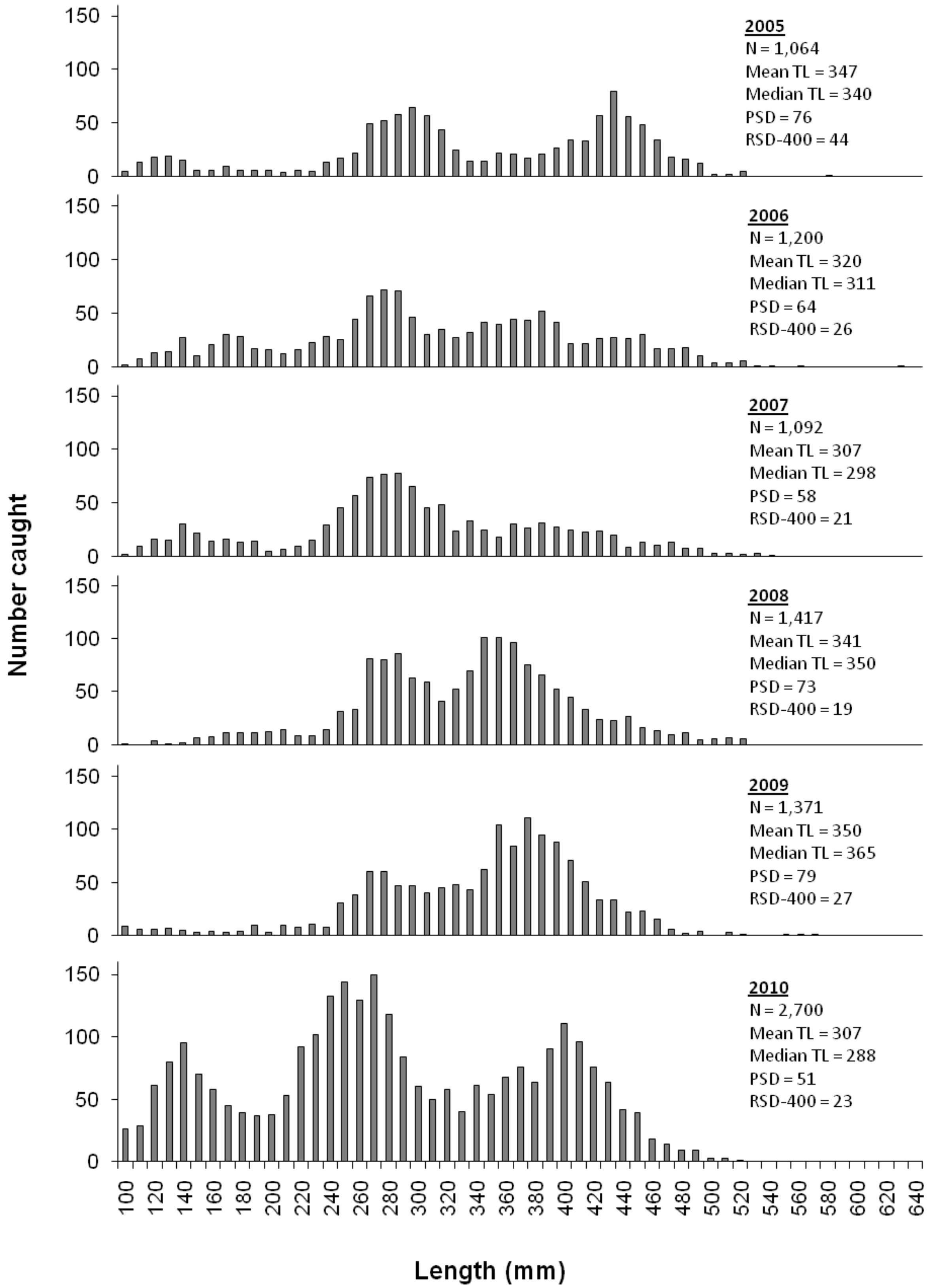

Figure 48. Length frequency distribution and total length statistics of rainbow trout collected by electrofishing in the Box Canyon reach of the Henrys Fork Snake River, Idaho, 2005 - 2010.

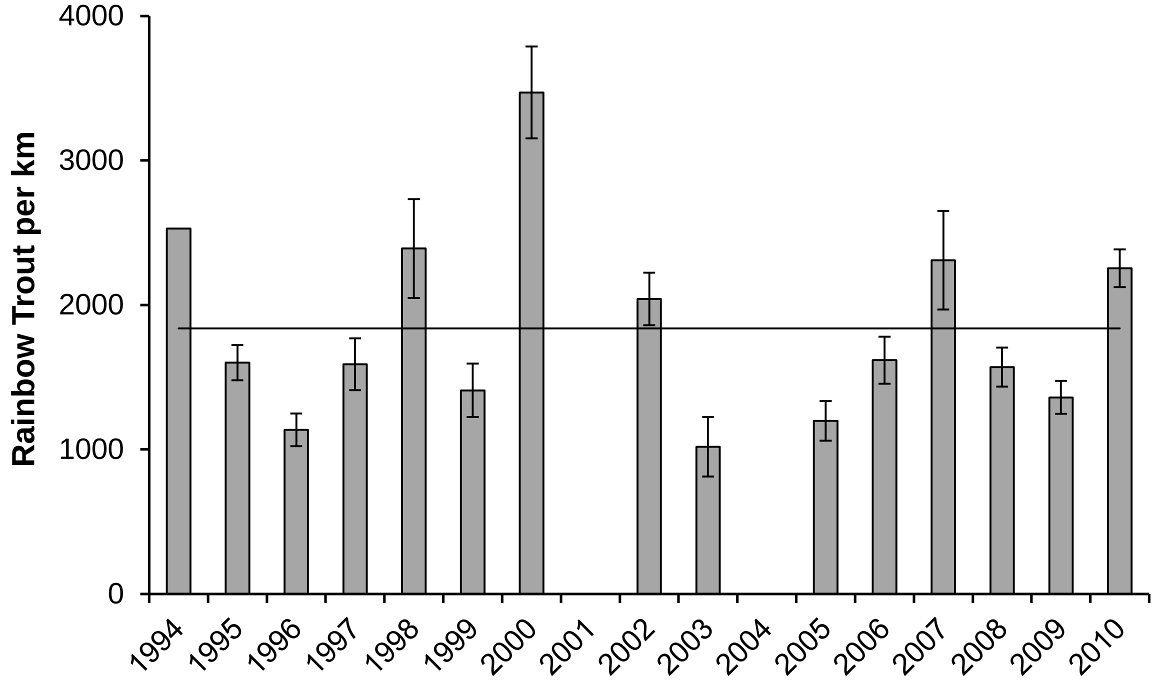

Figure 49. Rainbow trout population estimates for the Box Canyon reach of the Henrys Fork Snake River, Idaho 1994 to 2010. Error bars represent 95% confidence intervals. The solid line represents the long-term average rainbow trout density, not including the current years' survey.

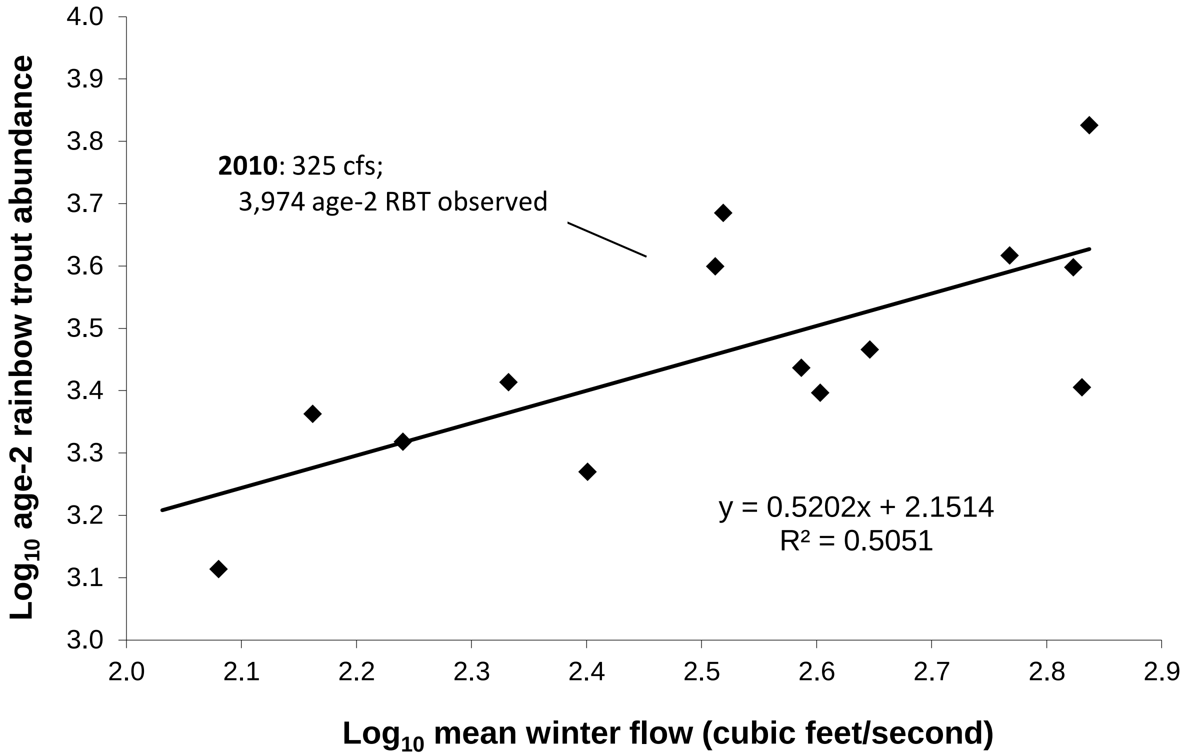

Figure 50. The relationship between age-2 rainbow trout abundance and mean winter flow (cfs) during the first winter of a fish's life from 1995 - 2010; $\log_{10}$ age-2 trout abundance = 0.5202 $\log_{10}$ flow (cfs) + 2.1514, (r^2=0.51; n=14, P=0.0044).

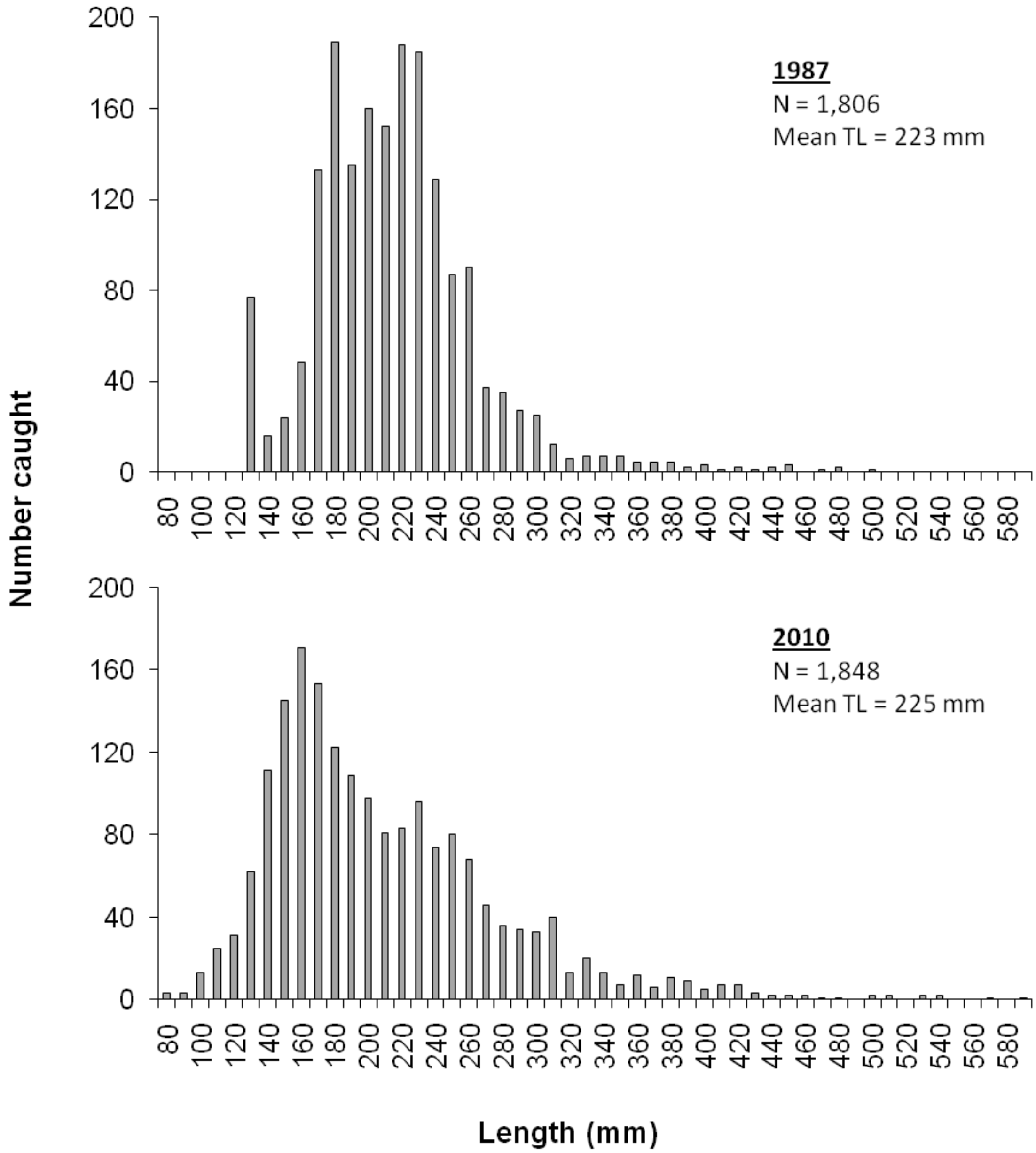

Figure 51. Length frequency distribution of rainbow trout collected by electrofishing in the Riverside reach of the Henrys Fork Snake River, Idaho, 1987 (Angradi and Contor) and 2010.

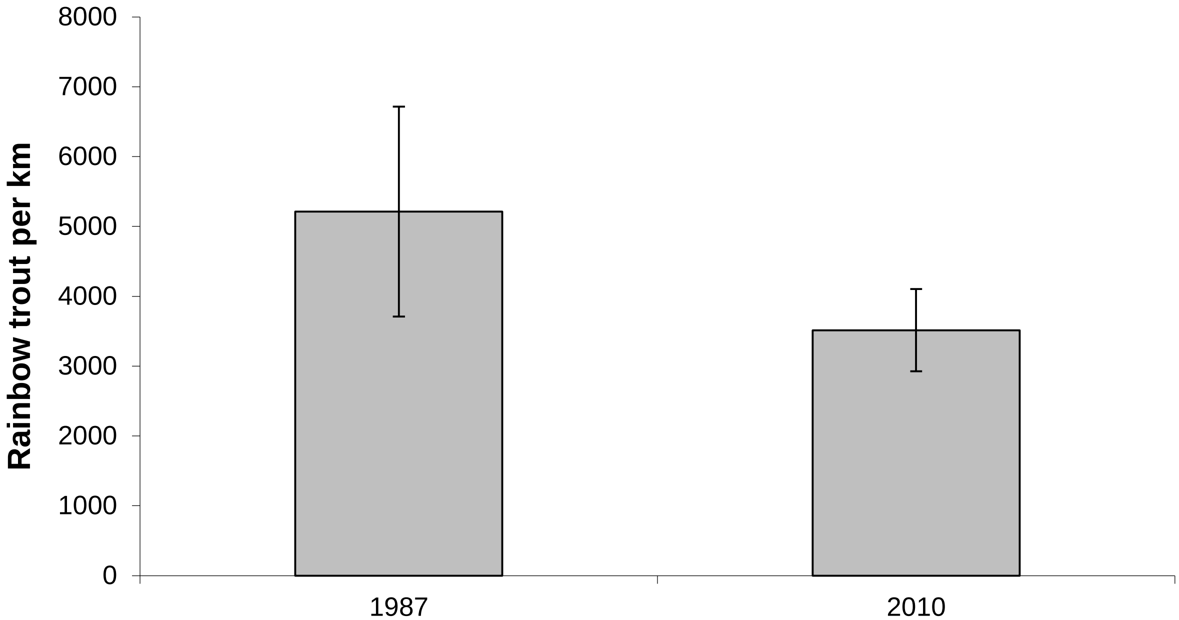

Figure 52. Rainbow trout population estimates from the Riverside reach of the Henrys Fork Snake River, Idaho, from 1987 (Angradi and Contor) and 2010.

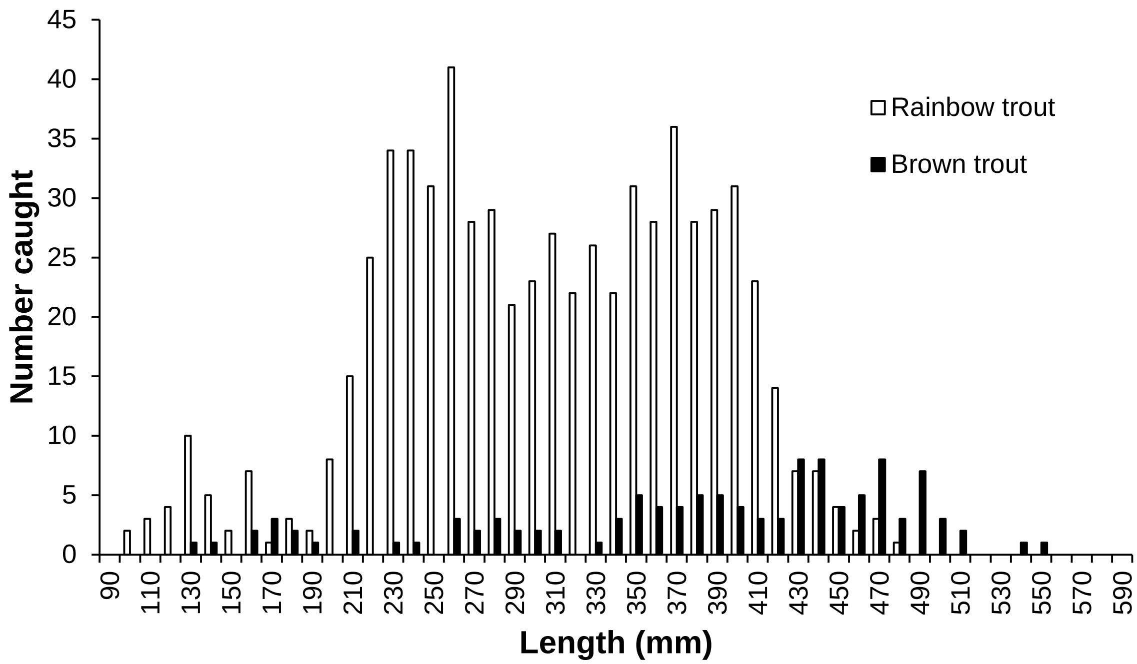

Figure 53. Length frequency distribution of rainbow trout (open bars) and brown trout (solid bars) in the Stone Bridge reach of the Henrys Fork Snake River, Idaho, 2010.

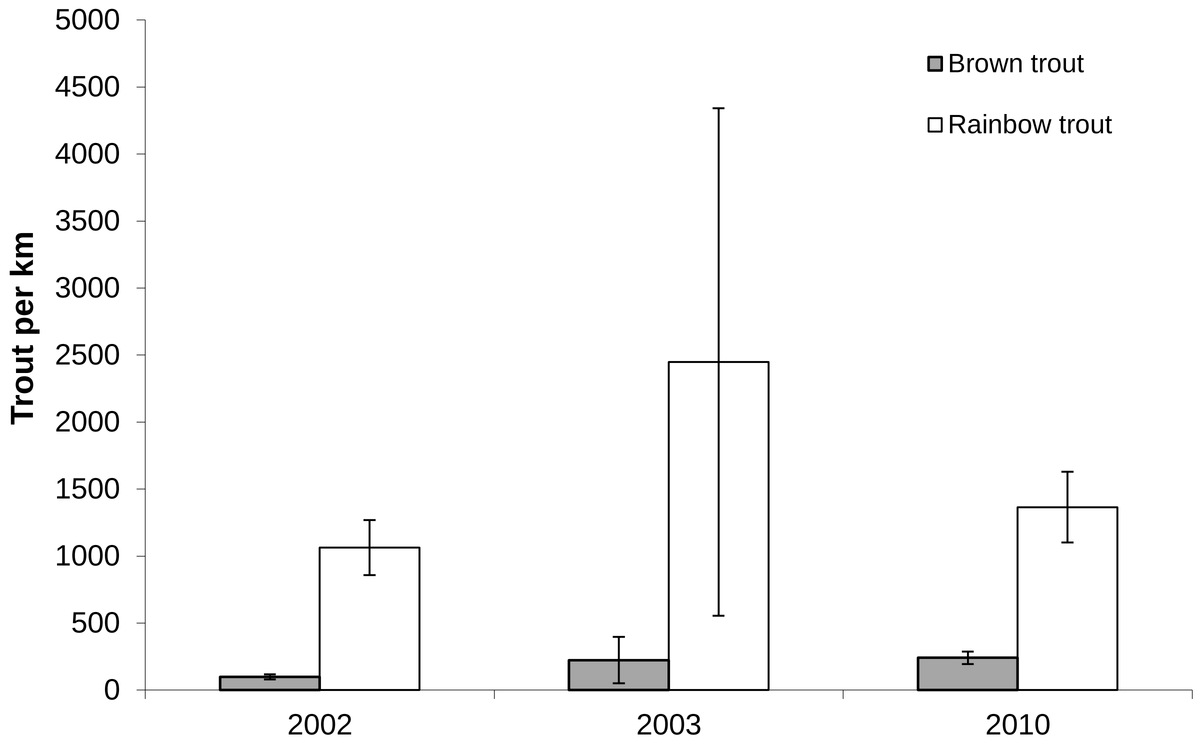

Figure 54. Rainbow trout (open bars) and brown trout (solid bars) population estimates (Log-likelihood method) for the Stone Bridge reach of the Henrys Fork Snake River, Idaho 2002 through 2010. Error bars represent 95% confidence intervals.

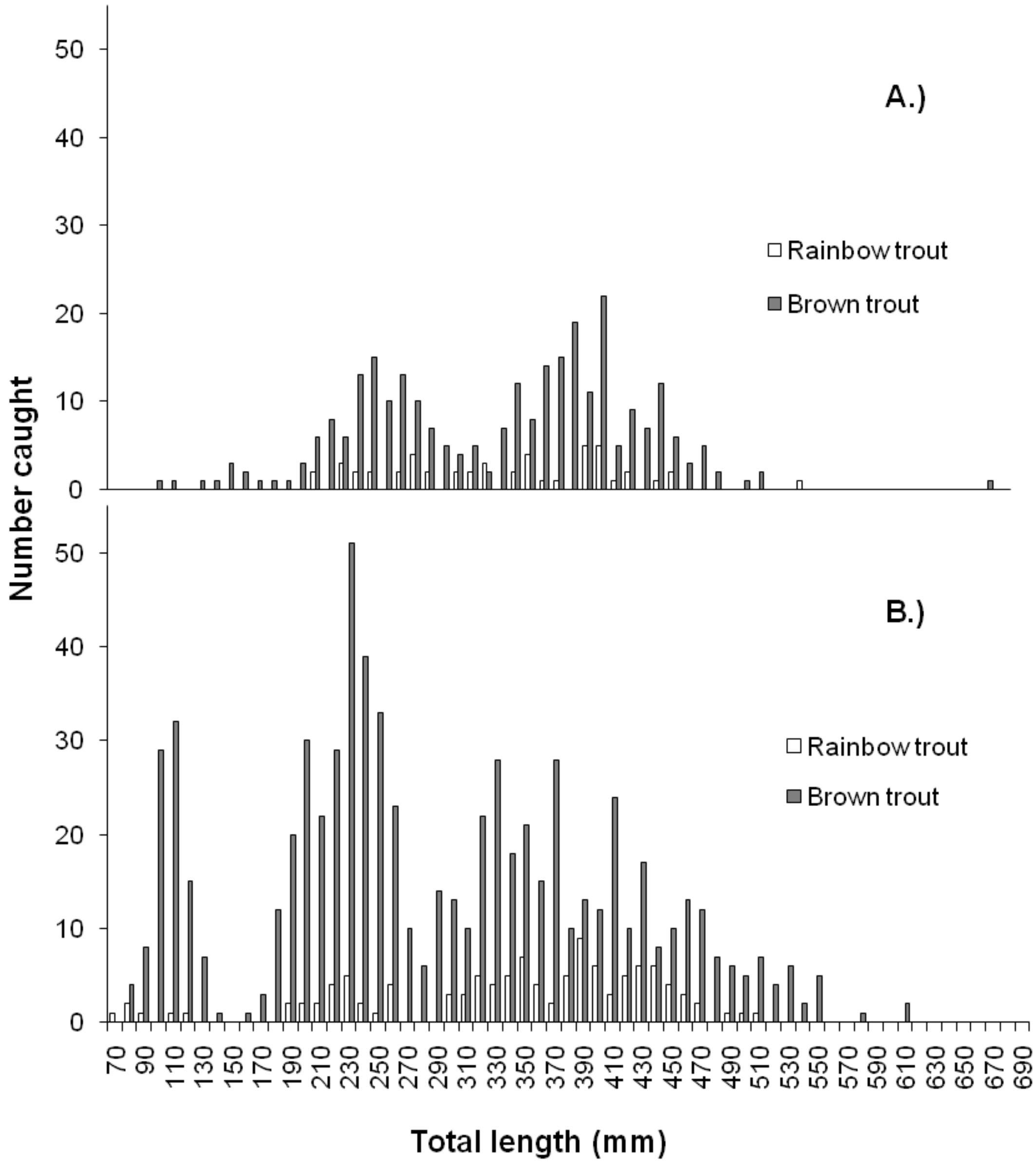

Figure 55. Length frequency distribution of rainbow trout and brown trout in the St. Anthony reach of the Henrys Fork Snake River, Idaho, during (A) May and (B) October 2010.

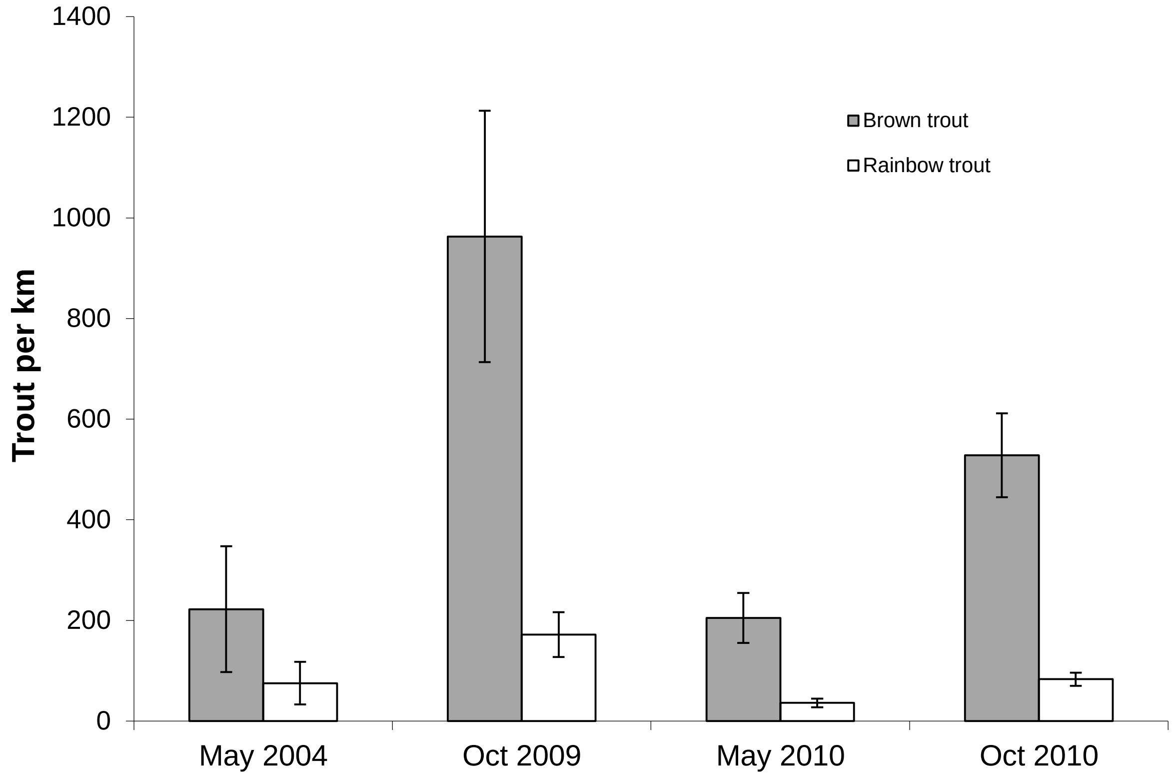

Figure 56. Trout population estimates (Log-likelihood method) for the St. Anthony reach of the Henrys Fork Snake River, Idaho 2004 through 2010. Error bars represent 95% confidence intervals. Due to a low number of recaptures, species population estimates and confidence intervals are estimated from partitioning the total trout population estimate by percent species composition.

Table 20. Trout population index summaries for the Henrys Fork Snake River, Idaho 2010.

River Reach	Mean Length (mm)	Median Length (mm)	PSD	RSD-400	RSD-500	Density (No./km)	Percent Species Composition
Box Canyon							
Rainbow trout	307	288	51	23	1	2,254	99
Riverside							
Rainbow trout	225	209	23	4	1	3,515	99
Stone Bridge							
Rainbow trout	317	317	58	15	0	1,364	85
Brown trout	389	405	87	57	7	241	15
St. Anthony (spring)							
Rainbow trout	345	356	65	35	2	36	15
Brown trout	347	367	66	32	1	205	85
St. Anthony (fall)							
Rainbow trout	360	375	81	36	2	68	14
Brown trout	322	315	56	26	5	552	86

Table 21. Trout population estimate summary from the Henrys Fork Snake River, Idaho during 2010.

River reach	No. marked	No. captured	No. recaptured	Population Estimate	Confidence Interval (+/- 95%)	Density (No./ km)	Discharge (cfs)[a]
Box Canyon							
-RBT	1,309	1,292	262	8,341	7,857 - 8,825	2,254	626[b]
Riverside							
-RBT	773	780	36	18,138	15,106 - 21,170	3,515	1,294[b]
Stone Bridge[c]							
-RBT	301	362	18	6,276	5,062 - 7,490	1,364	424[b]
-BNT	48	69	4	1,108	893 - 1,322	241	424[b]
St. Anthony[c] (spring)							
-RBT	23	28	2	252	191 - 313	36	1,550[d]
-BNT	176	116	16	1,436	1,088 - 1,786	206	1,550[d]
St. Anthony[c] (fall)							
-RBT	27	79	6	582	490 - 674	83	908[d]
-BNT	239	383	29	3,695	3,111 - 4,279	528	908[d]

[a] Represents the mean discharge value between marking and recapture events.

[b] Data obtained from USGS gauge near Island Park Dam (13042500)

[c] Species estimate determined by partitioning total trout log-likelihood estimate by percent species composition

[d] Data obtained from USGS gauge near St. Anthony (13050500)

STREAM SURVEYS

ABSTRACT

We sampled 24 locations in the Willow Creek drainage in July 2010 to document species composition and estimate densities of Yellowstone cutthroat trout *Oncorhynchus clarkii bouvieri* and brook trout *Salvelinus fontinalis*. Yellowstone cutthroat trout were found in 45% of the fish bearing streams sampled. Cutthroat trout were absent from three streams where they had been documented in earlier surveys, and present in one stream where they had not been seen previously. In Willow Creek and Sellars Creek, density estimates increased from previous surveys. Additional surveys and long term monitoring are necessary to document the validity of observed changes throughout the Willow Creek drainage.

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INTRODUCTION

Yellowstone cutthroat trout *Oncorhynchus clarkii bouvieri* have suffered declines in abundance and distribution across their native range (May et al. 2003). Declines have been attributed to factors such as hybridization with and/or competition and displacement by introduced non-native trout, habitat alterations, and over harvest by angling (Varley and Gresswell 1988). Although Yellowstone cutthroat trout are more abundant and have a broader distribution than any of the other non-anadromous cutthroat trout subspecies, range wide declines have resulted in isolated populations and ultimately, a petition for listing under the Endangered Species Act (USFWS 2001).

Yellowstone cutthroat trout are native to the Willow Creek drainage of eastern Idaho (Figure 57), and persist despite altered and degraded habitat throughout the watershed, and the presence of non-native trout species. In 1976, Ririe Dam was built for flood control and irrigation storage, creating Ririe Reservoir, which has a total capacity of 80,540 acre feet, and is located 32 km above the confluence with the Snake River. The segment of Willow Creek below the reservoir is annually dewatered during the winter to prevent flooding near Idaho Falls due to ice buildup. Willow Creek below Ririe Reservoir maintains a seasonal connection to the Snake River, but does so through a series of irrigation canals, and there is no upstream passage into the Reservoir. Prior to dewatering lower Willow Creek in 1976, the catch rate was 0.44 trout/hour with 10,500 hours (5,600 angler days) of effort expended, annually. No creel survey has been conducted in recent years; however, aside from the reach of Willow Creek immediately below Ririe Dam, the fishery is now largely non-existent.

The 153 km of streams in the Willow Creek drainage above Ririe Reservoir are mainly in narrow canyons and contain brook trout *Salvelinus fontinalis* and genetically pure Yellowstone cutthroat trout. Water flows vary from extremes of several thousand cubic feet per second during runoff to a few cubic feet per second in late summer and winter in Willow Creek. Since 1924, up to 20,000 acre-feet of water have been diverted annually from the Willow Creek drainage to Blackfoot Reservoir through Clark's Cut Canal. Intense grazing combined with a sustained drought have contributed to poor riparian habitat conditions in the upper watershed, impacting water quantity and quality as a result. Currently, Willow Creek and 15 of its tributaries are 303 (d) listed streams, with sediment and temperature being the primary pollutants of concern (Thompson 2004). A water quality program has been initiated to reduce loss of top soils and improve the water quality of Willow Creek above Ririe Dam. Riparian habitat improvement through improved grazing management is a high priority on both state and private lands.

Native populations of Yellowstone cutthroat trout and/or non-native brook trout are found in numerous tributaries to Willow Creek. Cutthroat trout in the mainstem areas of Willow Creek and Grays Lake Outlet are likely dependent on downstream movement from tributary spawning and nursery areas. Cutthroat trout populations are presently depressed in the drainage but remain viable. Hatchery catchable rainbow trout and brown trout fingerlings are no longer stocked in the Willow Creek drainage above Ririe Reservoir, and although brown trout have been stocked and found in past surveys, none have been collected in surveys conducted from 2000 through 2005. No wild rainbow trout have been found in the Willow Creek drainage and genetic surveys in 1999 and 2000 have documented that Willow Creek cutthroat trout are free of rainbow trout *O. mykiss* introgression (Meyer et al. 2006).

The objectives of this study were to assess the status of Yellowstone cutthroat trout in the Willow Creek drainage above Ririe Reservoir and compare to previous surveys to document changes in population density and distribution.

STUDY AREA

The Willow Creek drainage is located between the South Fork Snake River and Blackfoot River drainages, encompassing 1,687 km^2 of Bingham, Bonneville, and Caribou counties (Figure 57). Elevation in the drainage is relatively low, ranging from a valley floor at 1,200 m to peaks less than 2,200 m. All stream surveys were conducted in the Willow Creek drainage above Ririe Reservoir.

METHODS

Stream samples in the Willow Creek drainage conducted in 2010 were a cooperative effort between fisheries staff from the Upper Snake Regional office and the Nampa Research office. The majority of sample locations were repeated sites used in long-term population monitoring.

We used backpack electrofishers on July 19 - 22, during relatively low to moderate flow conditions (after spring runoff) to facilitate effective fish capture and standardization of sampling conditions. Three sample crews consisting of two to four people used backpack electrofishers and multiple-pass depletion methods to estimate trout abundance. We identified all collected trout to species before measuring for total length (mm) and releasing at the completion of the multiple-pass collecting period. Sample reaches were 100 m in length in most instances. Population estimates and 95% confidence intervals were estimated with MicroFish 3.0 (Van Deventer 2006) where appropriate. We used all trout species combined in our population estimates, and created species-specific density estimates by proportioning out densities based on relative abundance of the various species collected at each site. Capture efforts were focused on salmonids, but at each site where they occurred, nongame fish were captured and identified to species. Survey results were compared to surveys conducted in 2005 (presence/absence and/or density) for each sample location.

RESULTS

A total of 24 stream surveys were completed in the Willow Creek drainage, 19 of which were repeated surveys from 2005. Of these 24 sites, 15 were surveyed by electrofishing (Figure 58). Of the 9 sites surveyed but not electrofished, one was dewatered while the other 8 sites were inundated with beaver dams, making electrofishing surveys impractical. Of the 15 sites where electrofishing occurred in 2010, fish were present in 11 (73%) sites. Of these 11 sites bearing fish, Yellowstone cutthroat trout were present in five sites (45%, Table 22). Allopatric populations of Yellowstone cutthroat trout were found in samples from Tex Creek, Homer Creek and Lava Creek. Yellowstone cutthroat trout were found in combination with brook trout in two sample sites (Sellars Creek and Willow Creek); cutthroat trout were not found in any other sites where electrofishing occurred. Trout density (fish per $100m^2$) was estimated at three sites (Willow Creek, Mill Creek, and Sellars Creek), and ranged from 4.0 to 16.0 (Table 23).

Yellowstone cutthroat trout were found in one of two sites electrofished in Homer Creek during 2010, which shows increased distribution from the 2005 survey where no Yellowstone cutthroat trout were documented. Conversely, one site sampled in both Birch and Brockman creeks in 2010 did not document cutthroat trout, after they had been observed in 2005. In Mill

Creek, both Yellowstone cutthroat trout and brook trout were observed in 2005, while only brook trout were observed in one site in 2010.

In 2005, brook trout density (fish/100m^2) in Mill Creek was 20.0 and no cutthroat were captured. The same site was surveyed again a week later, and brook trout density was 3.09, while cutthroat trout was 1.85. During 2010, brook trout density was 9.20 while cutthroat were not observed. Trout density was not documented in Willow Creek or Sellars Creek in 2005, but estimates were made in 2000 and 2001, respectively. Yellowstone cutthroat trout (>100mm) density in Willow Creek was estimated at 23.3 fish per 100m in 2000, and increased to 39.2 in 2010. In Sellars Creek, cutthroat trout density increased from 0.018 per 100m^2 in 2001 to 15.8 in 2010.

DISCUSSION

Yellowstone cutthroat trout in the Willow Creek drainage appear to be relatively stable, though not overly abundant. Willow Creek and Sellars Creek appear to be strongholds within the drainage and while increases in density from previous surveys are encouraging, Yellowstone cutthroat trout were not found in three of the six streams that they had been documented in during the 2005 surveys. Cutthroat trout were documented in low density in Birch, Mill, and Brockman creeks in 2005, while in 2010 only brook trout were observed in Mill Creek. Brockman Creek contained no trout, and no fish were observed in Birch Creek. Increased future sampling may again document Yellowstone cutthroat trout in these streams, as only one site was sampled in each stream. Brockman Creek, the largest of these three streams, historically contained six survey locations, five of which we were unable to sample due to the presence of beaver ponds in the sample reach. Increased sampling throughout the Mill Creek drainage is also recommended to determine if brook trout have displaced Yellowstone cutthroat trout. Additionally, Yellowstone cutthroat trout were documented in lower Homer Creek in 2010, which was not seen in 2005; increased future sampling throughout this drainage is recommended to document the extent of Yellowstone cutthroat trout distribution.

Numerous electrofishing surveys have been conducted throughout the Willow Creek drainage since the early 1980's and many discrepancies exist in the names of sampling locations. Many locations have different names for the same sample location and many of these sampling locations were created before the implementation of Global Positioning System technology, and did not contain adequate site descriptions to replicate sampling. We recommend utilizing the site names for each sampling location listed in Appendix A, and verifying the starting position with UTM coordinates to establish long-term monitoring sites for future sampling efforts.

MANAGEMENT RECOMMENDATIONS

1. Reconcile discrepancies in historic sampling locations and establish a list of long-term monitoring sites, to be surveyed on a 3-5 year basis.

2. Identify areas where survey data is lacking and incorporate into long-term monitoring sites.

3. Identify priority areas for stream habitat restoration.

Figure 57. The Willow Creek drainage, located in eastern Idaho.

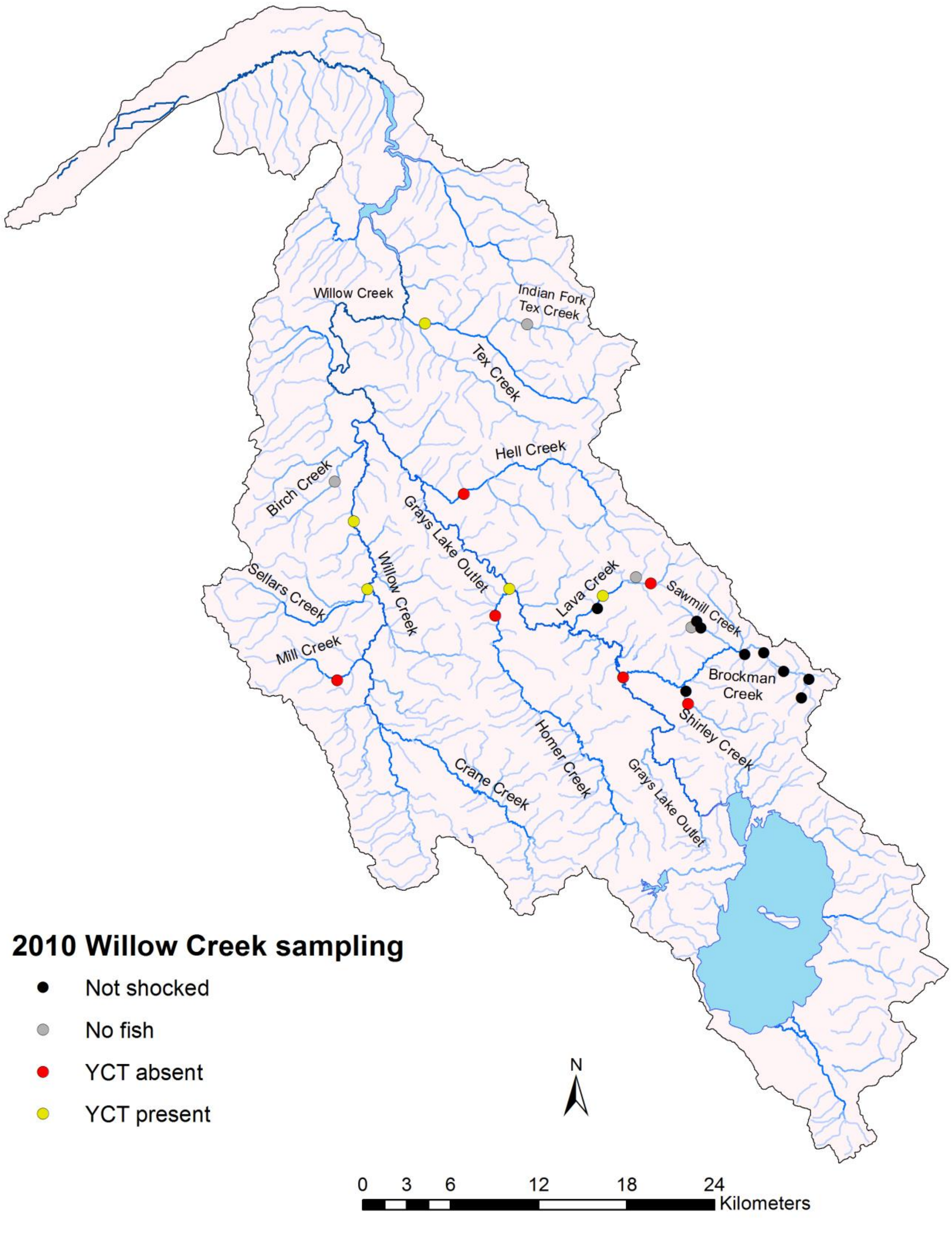

Figure 58. Sample locations for stream surveys conducted in the Willow Creek drainage, Idaho, 2010.

Table 22. Summary statistics and presence/absence of Yellowstone cutthroat trout (YCT) and brook trout (BKT) for streams sampled in the Willow Creek drainage, Idaho 2010.

Stream	Site Name	Electrofished?	Fish Present	YCT Present	BKT Present	Comments
Tex Creek	Road crossing	Y	Y	Y	N	Other species present: [A]
Indian Fork Tex Creek	Middle	Y	N	-	-	
Birch Creek	Above diversion	Y	N	-	-	
Sellars Creek	Corsi old site 1	Y	Y	Y	Y	Other species present: [A, B, C, D]
Mill Creek	Corsi repeat	Y	Y	N	Y	Other species present: [A, B, C, D]
Hell Creek	1	Y	Y	N	N	Other species present: [A, E]
Homer Creek	Lower	Y	Y	Y	N	Other species present: [A, B, C, D]
Homer Creek	Middle	Y	Y	N	N	Other species present: [A, C, D, E]
Lava Creek	Below NF	Y	Y	N	N	Other species present: [A]
Lava Creek	2005 #007	N	-	-	-	Beaver pond, unable to sample
Lava Creek	Mid #2	Y	Y	Y	N	Other species present: [A, B, C, D]
Lava Creek - unnamed tributary	Only site on trib	Y	N	-	-	
Brockman Creek	Mouth	Y	Y	N	N	Other species present: [A, B, C, D]
Brockman Creek	#3	N	-	-	-	Beaver pond, unable to sample
Brockman Creek	#4	N	-	-	-	Beaver pond, unable to sample
Brockman Creek	#5	N	-	-	-	Beaver pond, unable to sample
Brockman Creek	#6	N	-	-	-	Beaver pond, unable to sample
Brockman Creek - unnamed tributary	2005 #437	N	-	-	-	Dewatered, unable to sample
Shirley Creek	Lower	N	-	-	-	Beaver pond, unable to sample
Shirley Creek	Upper	Y	Y	N	N	Other species present: [A, B, C, D]
Sawmill Creek	2005 #465	Y	N	-	-	
Sawmill Creek	#014 - upper fork	N	-	-	-	Beaver pond, unable to sample
Sawmill Creek	#1 (2005 #435)	N	-	-	-	Beaver pond, unable to sample
Willow Creek	High Bridge	Y	Y	Y	N	Other species present: [B, C]

[A] = mountain sucker; [B] = mottled sculpin; [C] = redside shiner; [D] = speckled dace; [E] = longnose dace

Table 23. Trout density of streams sampled in the Willow Creek drainage, 2010.

Stream	Site	Reach Length (m)	YCT Density (no./100m^2)	BKT Density (no./100m^2)	Abundance Estimate[a] (+/- 95%)	Abundance Estimate[a] Age 1[b] and older (+/- 95%)
Sellars Creek	Corsi old site 1	296	15.8	0.2	244 (228 - 260)	176 (168 - 184)
Mill Creek	Corsi repeat	73	0.0	9.2	19 (18 - 20)	16 (15 - 17)
Willow Creek	High Bridge	183	4.0	<0.1	73 (53 - 93)	73 (53 - 95)

[a] – Abundance estimates include all trout species captured, for the entire reach sampled.
[b] – Age 1 and older fish were defined as being any trout 100 mm in length or greater.

<u>CROOKED AND MEYERS CREEK PROJECT</u>

ABSTRACT

Both Meyers Creek and Crooked Creek are located within the native range of Yellowstone cutthroat trout *Oncorhynchus clarkii bouvieri*, in the Medicine Lodge drainage, but until 2009 Myers Creek were dominated by brook trout *Salvelinus fontinalis*, and only the upper 8.5 km of Crooked Creek contained an allopatric population of Yellowstone cutthroat trout. In the fall of 2009, we treated approximately 6.5 km of Myers Creek to remove brook trout in preparation for reintroduction of Yellowstone cutthroat trout. Post-treatment electrofishing revealed one live brook trout in four sampling sites, indicating that the treatment was not successful at completely eradicating brook trout, but indicated the population was severely reduced from previous levels and 50 Yellowstone cutthroat trout, ranging from 40 - 340 mm were transplanted from Crooked Creek. During 2010, we sampled three sites in Myers Creek and one site in Crooked Creek to evaluate the success of the 2009 rotenone treatment and cutthroat trout reintroduction. Four Yellowstone cutthroat trout were found in two of the electrofishing sites in Myers Creek, and no brook trout were captured. Two of the cutthroat trout captured were transplants from Crooked Creek in 2009, while the other two captured cutthroat trout were unmarked, indicating that fish are migrating into Myers Creek. Future work includes continued monitoring of Myers Creek and additional Yellowstone cutthroat trout transplants from Crooked Creek as necessary, to establish this population.

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INTRODUCTION

Myers Creek originates in the Centennial mountain range of eastern Idaho, and is located in the Medicine Lodge Creek drainage. The streams within the Medicine Lodge drainage (and the four neighboring basins: Beaver-Camas, Birch, Little Lost and Big Lost) flow south and east, eventually sinking into the fractured basalts of the Snake River plain, and are collectively known as the Sinks drainages (Figure 59). It is believed that the Sinks drainages were last connected to each other via glacial Lake Terreton approximately 10,000 years ago. It appears that the only native fish in the Medicine Lodge drainage are shorthead sculpin *Cottus confusus,* mottled sculpin *C. bairdi*, and Yellowstone cutthroat trout *Oncorhynchus clarkii bouvieri*, which likely entered from the Henrys Fork Snake River drainage within the last 10,000 years.

Previous fisheries work in the Myers Creek drainage by IDFG and the U.S. Forest Service documented brook trout *Salvelinus fontinalis* in most of Myers Creek and a native population of Yellowstone cutthroat trout in Crooked Creek. Brook trout were the only species found in the upper 4.5 km of Myers Creek (above the confluence with Crooked Creek). Below the confluence with Crooked Creek, Myers Creek contained Yellowstone cutthroat trout and brook trout. While brook trout were also present in Crooked Creek, they were only observed in the lower 0.5 km, near the confluence with Myers Creek. Sampling in the upper 9.0 km of Crooked Creek found only Yellowstone cutthroat trout. No brook trout were observed in the 9.0 km of stream above the diversion or within the channelized reach (lower 1km) of Crooked Creek, indicating that the channelized reach of Crooked Creek may act as a barrier to brook trout migration. No other fish passage barriers were observed in Crooked Creek.

During the fall of 2009, we treated Crooked Creek and Myers Creek with rotenone to remove brook trout to aide in restoring the Yellowstone cutthroat trout population (High et al. 2011). After the rotenone treatment, we transplanted 50 Yellowstone cutthroat trout, ranging from 40 mm to 340 mm, from upper Crooked Creek into Myers Creek. All transplanted cutthroat trout had their adipose fin clipped prior to release into Myers Creek to determine if fish collected in future sampling efforts were from the transplant or if they migrated from Crooked Creek or were spawned naturally. The objectives of this study were to evaluate the rotenone treatment and Yellowstone cutthroat trout reintroduction efforts in Myers Creek conducted in 2009.

METHODS

We sampled three sites on Myers Creek and one site on Crooked Creek on July 6, 2010 with a backpack electrofisher to evaluate the success of the 2009 rotenone treatment. We sampled Myers Creek just above its confluence with Crooked Creek, in the middle reach near the Forest Service gate, and at the road crossing approximately 4.0 km upstream from Crooked Creek (Figure 60). Sites ranged from 50 to 75 m (Table 24). We also sampled 100 m of Crooked Creek just below the Myers Creek confluence (Figure 60). Sites were selected based on high abundance of brook trout observed in these areas during 2008 (IDFG files). We electrofished a small segment of Crooked Creek on August 5, 2010 to collect additional Yellowstone cutthroat trout for stocking into Myers Creek.

RESULTS AND DISCUSSION

We did not detect any brook trout in Myers Creek or Crooked Creek in the four sites sampled in 2010. The rotenone treatment in 2009 appears to have been successful in removing brook trout from both streams, or has severely limited their abundance. We did not capture any fish in Crooked Creek. In the three sample sites in Myers Creek, we captured two Yellowstone cutthroat trout in the lowest site, just above Crooked Creek. The two fish captured in this site were both unmarked, suggesting that native Yellowstone cutthroat trout are actively moving into Myers Creek. In the middle Myers Creek site, two adipose-clipped Yellowstone cutthroat trout were captured, indicating that transplants from Crooked Creek in 2009 survived and reintroduction efforts were successful. We did not capture any cutthroat trout <100mm, which would have indicated natural reproduction has occurred in 2010. On August 5, 2010, we transplanted an additional 10 Yellowstone cutthroat trout into Myers Creek from Crooked Creek, between 69 and 251 mm (mean: 149 mm). Future work in Myers Creek is needed to determine if natural reproduction is occurring and if additional transplants from Crooked Creek are necessary.

MANAGEMENT RECOMMENDATIONS

1. Continue periodic sampling over the next five years to determine success of brook trout eradication and Yellowstone cutthroat trout reintroduction in Myers Creek.

2. Continue Yellowstone cutthroat trout transplants from Crooked Creek into Myers Creek, as deemed necessary.

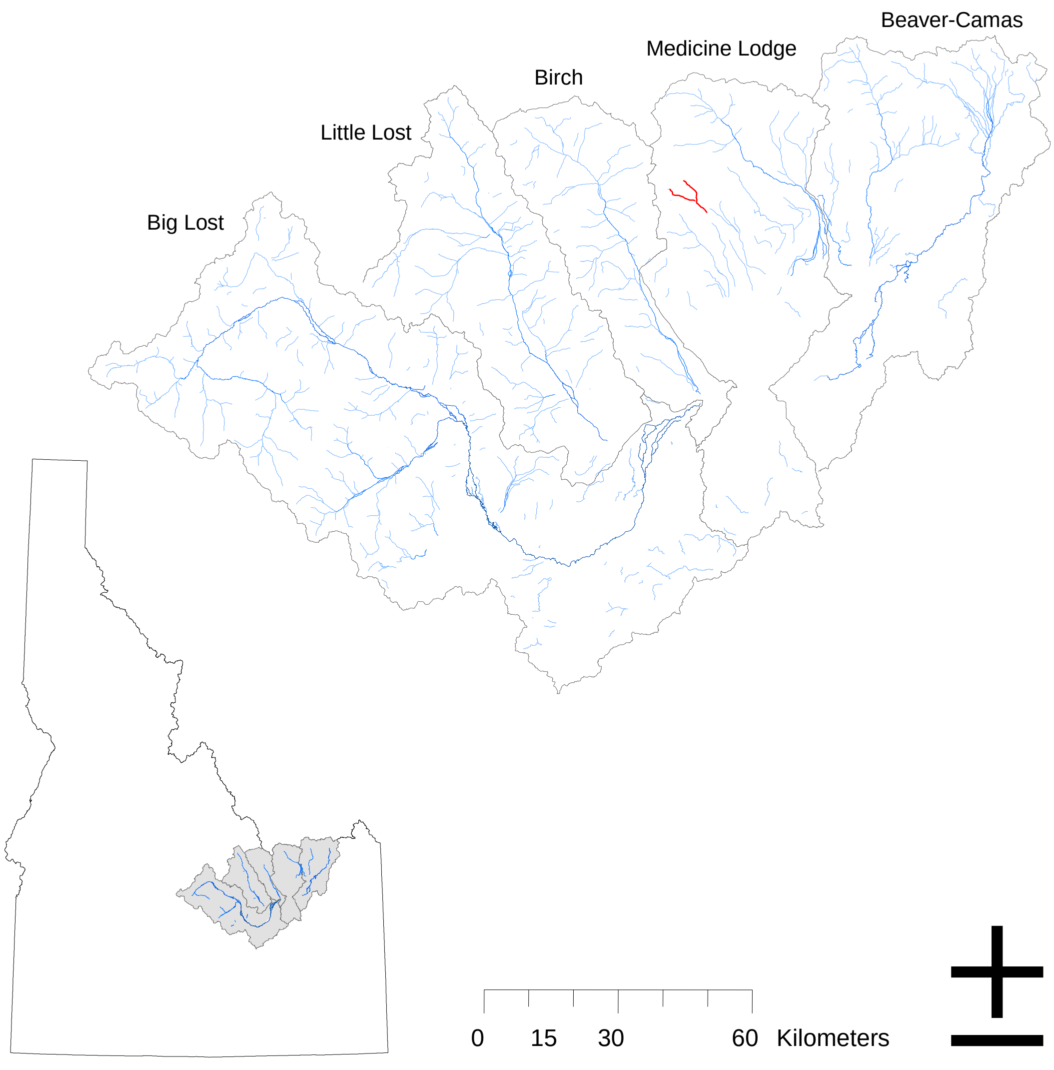

Figure 59. The Sinks drainages of Idaho, with Myers Creek and Crooked Creek highlighted in red.

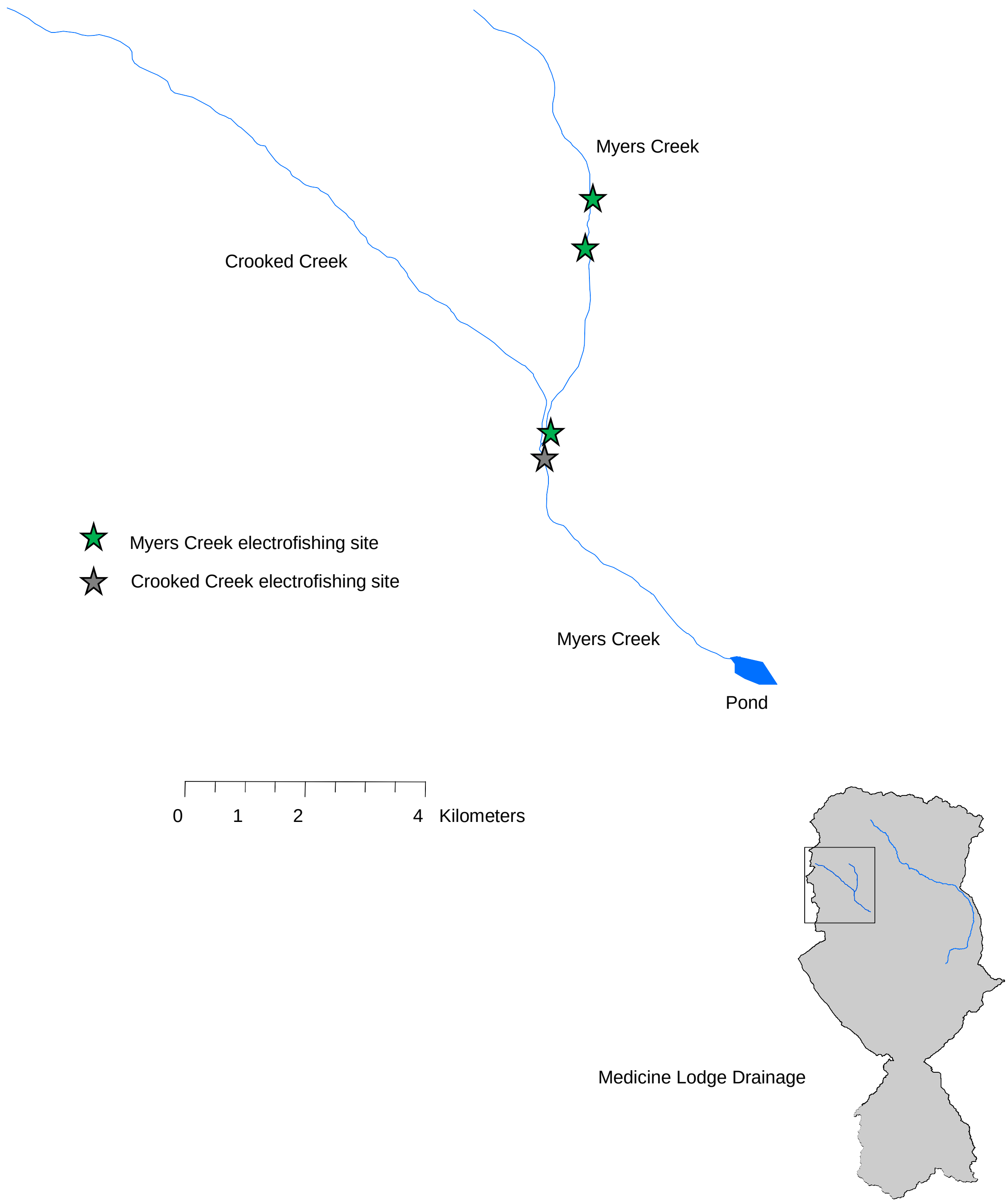

Figure 60. Post rotenone treatment electrofishing sample locations in the Myers Creek and Crooked Creek, during 2010.

Table 24. Locations of post-rotenone electrofishing sample sites in Myers Creek and Crooked Creek, 2010.

Stream	Site number	Zone	UTM E	UTM N	Location	Site length (m)
Myers Creek	1	12	363127	4902235	Above Crooked Creek confluence	75
Myers Creek	2	12	363896	4904730	At Forest Service gate	50
Myers Creek	3	12	363951	4905914	Road crossing, 4.0 km upstream	50
Crooked Creek	1	12	363086	4902120	Below Myers Creek confluence	100

ZOOPLANKTON MONITORING

ABSTRACT

We monitored zooplankton abundance and biomass to assess the forage resources in seven regional lakes and reservoirs. Zooplankton biomass and abundance were compared to past data to examine trends within the region and to evaluate our stocking densities in these waters. We assessed the cropping impacts by fish using the zooplankton ratio method (ZPR) and determined that preferred zooplankton are not being cropped by fish in any of the seven waters sampled. We used the zooplankton quality index (ZQI) to assess the overall abundance of preferred zooplankton and determine the appropriate stocking rate based on these data. During 2010, ZQI values across the region were generally lower than in previous years, aside from Palisades Reservoir, but the timing of sampling in this water body likely influenced our results. Historically, the stocking rate of the lakes and reservoirs in which we monitored zooplankton appears adequate, although recent declines in zooplankton, particularly in Mackay Reservoir and Henrys Lake, may be related to increased densities of kokanee *Oncorhynchus nerka* and trout due to natural reproduction.

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INTRODUCTION

Zooplankton is vital to lake and reservoir ecosystems because they form the base of the aquatic food web and influence fish production. Dillon (1996) showed that the presence of large zooplankton is directly linked to the success of fall hatchery trout fingerling stocking. However, fish stocking programs often fail to include basic zooplankton monitoring data as an evaluation of stocking rates. Zooplankton abundance data can be used to help evaluate hatchery trout stocking programs by estimating the relative production potential of a water body and the availability of preferred zooplankton as a food source for stocked fish.

METHODS

We collected zooplankton samples from seven lakes and reservoirs throughout the Upper Snake Region during 2010 (Figure 61), following the protocol described by Teuscher (1999). We collected zooplankton samples twice between early July and early September on Gem Lake, Island Park Reservoir, Mackay Reservoir, and Ririe Reservoir. We sampled Henrys Lake, Mud Lake, and Palisades Reservoir once during 2010. We did not sample Ashton Reservoir during 2010 as repairs to Ashton Dam resulted in the reservoir being drawn down during most of the season. To make comparisons across the region, we present the results from July zooplankton sampling this report, with the exception of Palisades Reservoir, which was sampled only once, in August 2010. During each sampling event, we collected samples from three locations within the lake or reservoir. We collected samples with three nets fitted with small (153:), medium (500:) and large (750:) mesh. We preserved zooplankton in denatured ethyl alcohol at a concentration of 1:1 (sample volume : alcohol). After ten days in alcohol, phytoplankton were removed from the samples by re-filtering through a 153: mesh sieve. The remaining zooplankton were blotted dry with a paper towel and weighed to the nearest 0.1 g. Biomass estimates were corrected for tow depth and reported in g/m. We estimated the relative production potential of each lake by estimating overall zooplankton biomass collected from the 153: net. We measured competition for food (or cropping impacts by fish) using the zooplankton productivity ratio (ZPR) which is the ratio of preferred (750:) to usable (500:) zooplankton. We also calculated the zooplankton quality index (ZQI) to account for overall abundance of zooplankton using the formula developed by Teuscher (1999):

$$ZQI = (500: + 750:) * ZPR$$

ZQI values obtained from zooplankton monitoring are used to assess stocking rates based on the recommendations from Teuscher (1999) (Table 25). We also examined zooplankton data (ZQI) from previous years to monitor trends in zooplankton abundance throughout the region and analyzed stocking data to determine if changes may be appropriate.

RESULTS AND DISCUSSION

Throughout the Upper Snake Region, mean zooplankton biomass from the 153: net ranged from 0.02 g/m (Gem Lake and Mud Lake) to 1.27 g/m (Island Park Reservoir) (Table 26). Teuscher (1999) recommends conservative stocking densities in water bodies with mean biomass estimates < 0.10 g/m. During 2010, only Gem Lake and Mud Lake zooplankton biomass estimates were below 0.10 g/m. ZPR values ranged from 0.24 (Mackay Reservoir) to 1.03 (Palisades Reservoir) (Table 26), which indicates that preferred zooplankton are not being cropped by fish in any of the samples water bodies throughout the region. ZQI values were highest for Palisades and Island Park Reservoirs and lowest for Mackay Reservoir, Gem Lake and Mud Lake (Table 26; Figure 62).

During 2010, ZQI values in Gem Lake, and Ririe and Palisades Reservoirs were similar to previous years. Gem Lake has consistently shown low zooplankton levels, likely related to the low retention time in this water body. Gem Lake is stocked with catchable rainbow trout *Oncorhynchus mykiss* and is managed as a yield fishery under general regulations, which is appropriate based on zooplankton monitoring data. Ririe and Palisades Reservoirs have consistently shown moderate zooplankton levels (Figure 62), although the timing of the Palisades sampling (August) may have contributed to the relatively high ZQI value observed in 2010. Ririe Reservoir ZQI was 0.41 in 2010, indicating that moderate stocking levels (75 – 150/acre) of fingerling are appropriate for this water body. Kokanee *O. nerka* fingerling and fry stocking in Ririe Reservoir have averaged 170 fish per acre for the past five years, which may be slightly high for the observed zooplankton levels, but angler reports indicate that kokanee stocking has provided a successful fishery the past several years. Palisades Reservoir ZQI was 0.86 in 2010, which was the second highest ZQI observed in Palisades Reservoir since 2006. This was also the highest ZQI of all lakes and reservoirs surveyed throughout the region in 2010, which may be related to the timing of this survey. Palisades Reservoir is stocked annually with approximately 250,000 fingerling Yellowstone cutthroat trout *O. clarkii bouvieri* (16 per acre) and 60,000 catchable Yellowstone cutthroat trout, although cutthroat trout stocking in 2010 was limited to 104,000 fingerlings and 450 catchables due to a disease outbreak at Jackson National Fish Hatchery. Although the forage base observed in our zooplankton surveys indicates that Palisades Reservoir could support heavier stocking of fingerlings, the historically low return to creel rates of hatchery fish combined with annual extreme fluctuations in reservoir levels may make additional stockings unwarranted.

Mackay Reservoir ZQI was 0.10 and has been in decline since 2006 (Figure 62). Since 2006, stocking of catchable rainbow trout has remained stable (approximately 21,000 annually [16 per acre]), and less than 20,000 rainbow trout fry and fingerling have been stocked. Also during this time period, kokanee stocking has only occurred once (25,000 fingerling [19 per acre] in 2009). Although stocking in Mackay Reservoir has remained well within appropriate levels based on ZQI values, an increasing kokanee population may be impacting zooplankton. Based on angler catch rates, it is believed that the kokanee population in Mackay Reservoir is increasing. Anecdotal reports indicate that wild kokanee reproduction in Mackay Reservoir is increasing, which may explain recent declines in zooplankton abundance.

Henrys Lake and Island Park Reservoir continue to be two of the most productive water bodies in the Upper Snake Region, although zooplankton monitoring during 2010 showed a decline from previous years (Figure 62). Island Park Reservoir and Henrys Lake ZQI values averaged 1.69 and 0.96 between 2006 and 2009, respectively, but dropped to 0.72 and 0.66 in 2010. This may be related to multiple factors, including but not limited to, fluctuating lake/reservoir levels, decreased retention time, and increased fish densities due to natural reproduction. Island Park Reservoir inflow and outflow are subject to drastic changes based on snowmelt and downstream irrigation demands, which likely influences zooplankton abundance. Natural reproduction of Yellowstone cutthroat trout appears to be increasing the trout density in Henrys Lake (see *Henrys Lake chapter* for more details), which likely will affect zooplankton abundance. ZQI results in 2010 indicate that current stocking densities in Henrys Lake (236 fish acre) may be too high for the amount of available forage.

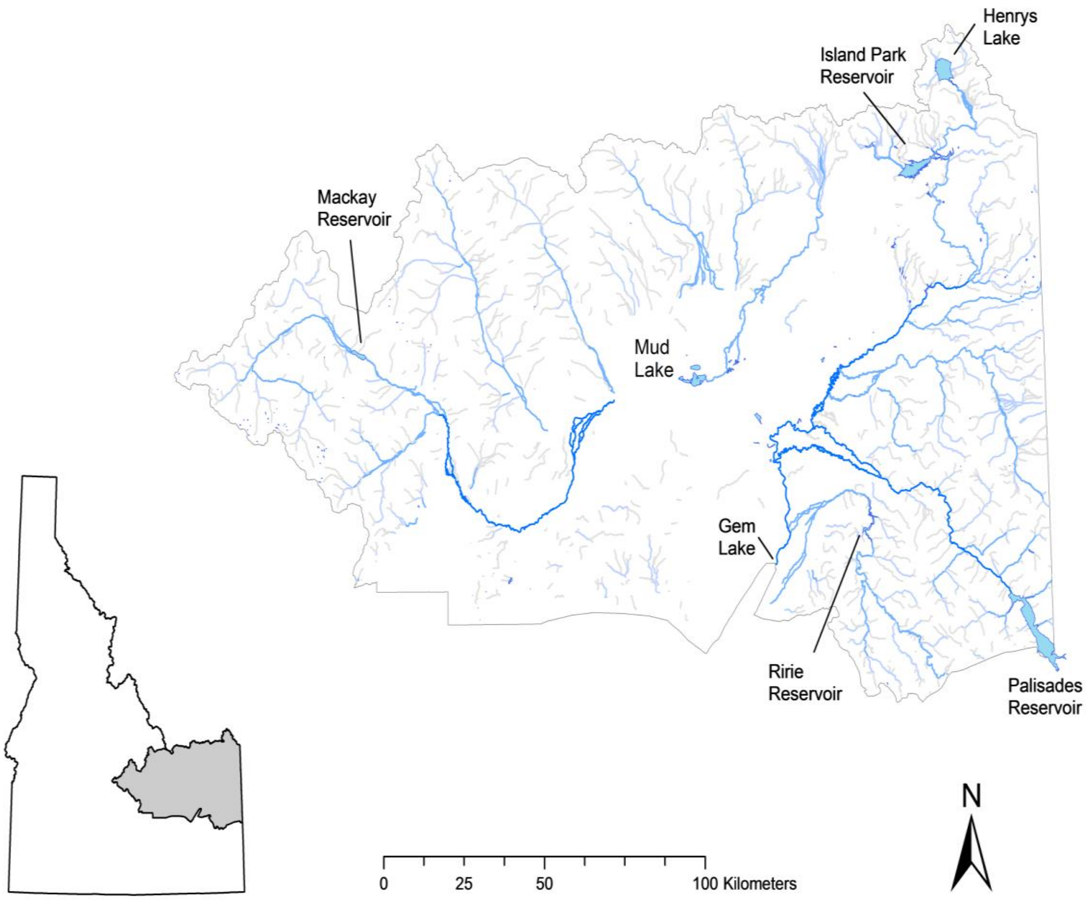

Figure 61. Upper Snake Region lakes and reservoirs where zooplankton samples were collected during 2010.

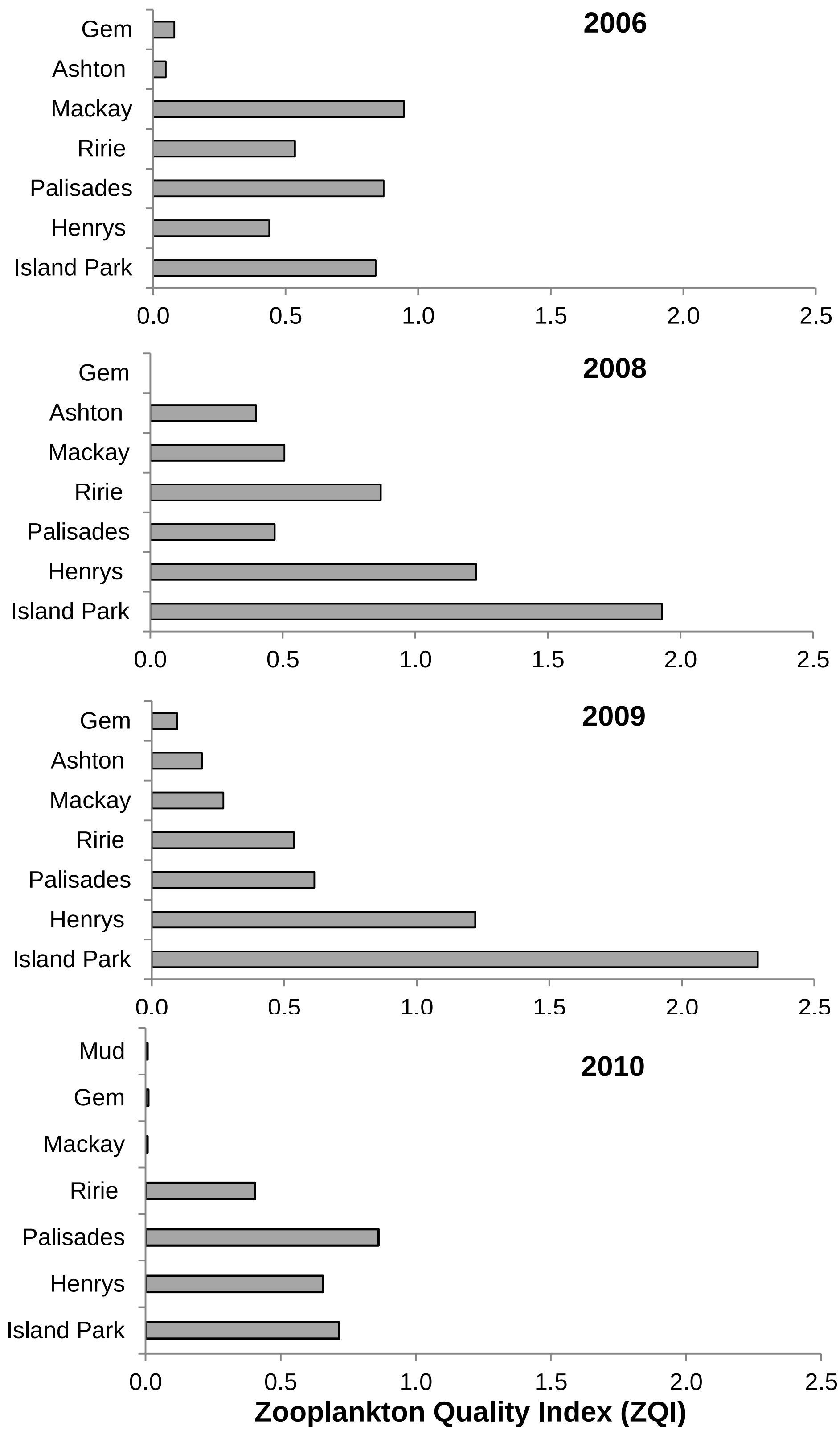

Figure 62. Zooplankton quality index (ZQI) values for lakes and reservoirs in the Upper Snake Region, from 2006 - 2010.

Table 25. Zooplankton quality index (ZQI) ratings and the recommended stocking rates from Teuscher (1999).

ZQI	**Stocking recommendation**
>1.0	High density fingerlings (150 – 300 per acre)
<1.0, >0.1	Moderate density fingerlings (75 – 150 per acre)
<0.1	Low density fingerlings (< 75 per acre) or stock catchables

Table 26. Mean zooplankton biomass (g/m) by mesh size, preferred to usable (750:500) zooplankton ratio (ZPR), and zooplankton quality index (ZQI = [500+750]*ZPR) for reservoirs in the Upper Snake Region of Idaho, July 2010.

	Net mesh (microns)				
Waterbody	153	500	750	ZPR	ZQI
Mud Lake*	0.02	0.02	0.01	0.25	0.01
Gem Lake*	0.02	0.02	0.01	0.45	0.01
Henrys Lake	0.69	0. 42	0.36	0.84	0.66
Island Park Reservoir	1.27	0.75	0.45	0.60	0.72
Mackay Reservoir	0.33	0.02	0. 01	0.24	0.01
Palisades Reservoir	0.60	0.41	0.42	1.03	0.86
Ririe Reservoir	0.66	0.40	0.25	0.63	0.41

*discrepancies in calculated ZPR and ZQI values are due to rounding 500 and 750 mesh tow values

APPENDICIES

Appendix A. Annual kokanee stocking in Island Park Reservoir, Moose Creek, and Big Springs Creek, 1944 – 2010.

	Island Park Reservoir		**Moose Creek**		**Big Springs Creek**	
Year	Fingerling	Fry	Fingerling	Fry	Fingerling	Fry
1944	67,770					
1945	51,510					
1968	360,000			107,724		
1969	200,000					
1981				503,198		
1982				199,800		
1984				760,300		
1985	833,690					
1988				104,720		25,200
1989				233,020		
1990	189,00		167,850			
1991	104,745		20,000	135,660		
1992	142,142		115,905			63,000
1993	200,624					
1994	596,250					
1995	500,000					
1996	5,000		419,100			
1997	554,315					
1998	125,304					
1999	41,600		304,807			
2000			579,128			
2001	474,640					
2002	402,648					
2003	30,000					
2004	203,695					
2005	248,000					
2006	418,575					
2007	620,760					
2008		223,040				
2009	125,875		62,938		62,938	
2010	108,575		54,287		54,287	

Appendix B. Location of Ririe Reservoir fall walleye index netting (FWIN) net locations during November 2010.

DATE	NET	LAKE STRATA	N	W	NET TYPE	LAKE DEPTH
11/9/2010	1	NORTH	440589	4825019	F	9m
11/9/2010	2	NORTH	440519	4824500	F	8 - 18m
11/9/2010	3	NORTH	440792	4822946	F	5 - 29m
11/9/2010	4	NORTH	440648	4822585	F	8 - 18m
11/9/2010	5	NORTH	440359	4822086	F	12 - 26m
11/9/2010	6	NORTH	440292	4821713	F	5.5 - 21m
11/15/2010	7	SOUTH	439282	4815593	S	1.8 - 2.4m
11/15/2010	8	SOUTH	439078	4816386	F	2.7 - 3.4m
11/15/2010	9	SOUTH	438634	4816697	S	3.7 - 4.3m
11/15/2010	10	SOUTH	438958	4816883	F	4.6 - 4.9m
11/15/2010	11	SOUTH	439466	4816885	S	6.7 - 7.0m
11/15/2010	12	SOUTH	440219	4816969	F	6.7 - 8.2m
11/17/2010	13	MIDDLE	441568	4818750	S	8.0 - 13.0m
11/17/2010	14	MIDDLE	441539	4819180	F	8.3 - 14.5m
11/17/2010	15	MIDDLE	441650	4820515	S	3.5 - 6.9m
11/17/2010	16	MIDDLE	441179	4820680	F	3.7 - 17.9m
11/17/2010	17	MIDDLE	440668	4820688	S	5.8 - 17.5m
11/17/2010	18	MIDDLE	440891	4821408	F	9.5 – 22.2m

Appendix C. Summary of walleye captured and implanted with transmitters in Ririe Reservoir, 2009-2010.

Tag ID	Date Tagged	Capture method[a]	Location	UTM E	UTM N	Total Length (mm)	Weight (g)	Sex	Water Temp (°C)
50	4/20/09	E	Willow Cr	440934	4812970	458	920	M	8.0
51	4/21/09	E	Willow Cr	440429	4814441	436	745	M	6.0
52	4/23/09	E	mouth of Willow Cr	440779	4813565	439	710	M	7.0
53	4/29/09	TN	#12 – Willow Cr arm	440415	4814412	442	765	M	6.0
54	4/29/09	E	Willow Cr	440991	4812337	414	670	M	9.0
55	4/29/09	E	Willow Cr	440966	4811956	402	545	M	9.0
56	4/30/09	E	Willow Cr	440979	4812387	480	1025	M	7.0
57	4/30/09	E	Willow Cr	440979	4812387	476	1005	M	7.0
58	4/30/09	E	Willow Cr	440979	4812387	420	745	M	7.0
59	5/1/09	E	Willow Cr	440979	4812380	453	945	M	8.0
60	5/1/09	E	Willow Cr	440979	4812380	474	1125	M	8.0
62	5/1/09	E	Willow Cr	440979	4812380	470	1025	M	8.0
63	5/1/09	E	Willow Cr	440979	4812380	415	665	M	8.0
64	5/1/09	E	Willow Cr	440979	4812380	434	725	M	8.0
65	5/2/09	E	Willow Cr	440984	4812102	455	975	M	8.0
66	5/2/09	E	Willow Cr	440984	4812102	480	1110	M	8.0
67	5/7/09	TN	#26	441010	4812864	455	875	M	7.0
68	5/7/09	TN	#22	440859	4813219	442	815	M	7.0
69	5/7/09	E	Willow Cr	440990	4811894	444	855	M	7.0
70	5/13/09	TN	#23	440919	4812916	511	1550	F	12.0
71	11/24/2009	GN	W shore, N of power lines	440448	4821950	476	1050	U	3.0
72	11/24/2009	GN	W shore, N of power lines	440448	4821950	465	1100	U	3.0
73	4/21/2010	E	Willow Cr	440749	4813900	500	1200	M	10.0
74	4/21/2010	E	Willow Cr	440749	4813900	560	2010	F	10.0
75	4/21/2010	E	Willow Cr	440749	4813900	505	1400	M	10.0
76	4/22/2010	TN	Net #1 - Willow Cr bay/point	439707	4815487	466	950	M	7.0
77	4/22/2010	E	Willow Cr	439707	4815487	495	1300	M	7.0
78	4/22/2010	E	Willow Cr	439707	4815487	481	1125	M	7.0
81	4/23/2010	E	Willow Cr	440723	4813879	483	1100	M	7.0
79	4/23/2010	E	Willow Cr	440723	4813879	491	1300	M	7.0
80	4/23/2010	E	Willow Cr	440723	4813879	522	1600	M	7.0

Appendix C. Summary of walleye captured and implanted with transmitters in Ririe Reservoir, 2009-2010 (cont.).

59	4/27/2010	E	Lower Willow Cr	440415	4814471	560	2050	F	11.0
61	4/27/2010	E	Willow Cr - Lower 1/2 mile	440786	4815193	456	925	M	9.0
82	4/27/2010	E	Willow Cr - Lower 1/2 mile	440786	4815193	517	1480	M	9.0
83	4/27/2010	E	Willow Cr - Lower 1/2 mile	440786	4815193	540	1650	M	9.0
84	4/27/2010	E	Willow Cr - Lower 1/2 mile	440786	4815193	447	775	M	8.0
85	4/27/2010	E	Willow Cr - Lower 1/2 mile	440786	4815193	468	1020	M	8.0
86	4/27/2010	E	Willow Cr - Lower 1/2 mile	440786	4815193	556	1625	U	8.0
87	4/27/2010	E	Willow Cr - Lower 1/2 mile	440786	4815193	505	1300	M	9.0
88	4/27/2010	E	Willow Cr - Lower 1/2 mile	440786	4815193	468	1100	M	8.0
89	4/27/2010	E	Willow Cr - Lower 1/2 mile	440786	4815193	471	1135	M	8.0
69	4/27/2010	E	Lower Willow Cr	440415	4814471	508	1580	M	8.0
50	4/27/2010	E	Lower Willow Cr	440415	4814471	537	1775	F	8.0

[a] = capture method: E = electrofishing; TN = trap net; GN = gill net.

Appendix D. Table 1. Density estimates and 95% confidence intervals for age-1 and older trout at the Conant and Lorenzo monitoring reaches.

	Conant							Lorenzo				
	>102 mm YCT/km	1.96 x SD	>152 mm RBT/km	1.96 x SD	>178 mm BRN/km	1.96 x SD	Sum trout/km	>102 mm YCT/km	1.96 x SD	>178 mm BRN/km	1.96 x SD	Sum trout/km
1982	1899	NA	26	NA	412	NA	NA					
1983												
1984												
1985												
1986	2890	402	NA	NA	641	253	NA					
1987								422	207	531	160	953
1988	1491	148	NA	NA	340	310	NA	187	47	300	88	487
1989	1610	108	63	26	191	162	1865	248	98	185	38	433
1990	2330	173	204	64	369	133	2903	308	145	272	99	580
1991	1399	136	134	54	195	52	1728	445	146	369	56	814
1992												
1993	1512	150	110	51	135	78	1757	487	155	555	105	1042
1994												
1995	1230	147	270	72	294	176	1795	568	116	639	101	1207
1996	1502	225	594	420	314	78	2410					
1997	1145	76	604	73	369	203	2118					
1998	1691	204	461	79	249	36	2401					
1999	1847	163	654	127	512	169	3013	335	81	1150	161	1485
2000												
2001												
2002	841	119	785	195	288	122	1913	246	65	1030	117	1275
2003	840	119	931	226	240	99	2010	237	133	926	110	1163
2004	478	61	530	104	383	204	1391					
2005	658	205	421	211	206	105	1285	76	54	771	91	847
2006	749	104	677	178	329	70	1755	116	25	1761	148	1877
2007	1380	142	825	113	530	117	2734	NA	NA	1125	110	NA
2008	1065	156	574	108	380	57	2018	NA	NA	778	132	NA
2009	826	87	1408	302	307	48	2541	218	93	915	90	1133
2010	1211	284	1174	666	479	136	2865	233	83	653	49	885

Appendix D. Table 2. Locations of South Fork Snake River fish population monitoring sites, tributary weirs, and survey sites on Palisades Creek and the Dry Bed Canal (WGS 84).

Site	Upstream boundary	Downstream boundary
Conant monitoring site	12T 467846 E 4810899 N	12T 465305 E 4814032 N
Lorenzo monitoring site	12T 430743 E 4841275 N	12T 428214 E 4844051 N
Burns Cr Weir	12T 462063 E 4827984 N	NA
Pine Cr Weir	12T 473373 E 4819000 N	NA
Rainey Cr Weir	12T 478494 E 4811841 N	NA
Palisades Cr Weir	12T 480668 E 4803039 N	NA
Palisades Cr electrofishing removal	12T 486968 E 4807952 N	12T 480668 E 4811841 N
Dry Bed Creel Survey	12T 439334 E 4833108 N	12T 435049 E 4807952 N

Appendix E. Locations used in population surveys on the Henrys Fork Snake River, Idaho 2010. All locations used NAD-27 and are in Zone 12.

	Start		Stop	
Reach	Easting	Northing	Easting	Northing
Box Canyon	468677	4917703	467701	4914352
Riverside	464773	4899817	465657	4896509
Stone Bridge	470272	4882945	466075	4882923
St. Anthony	442187	4866559	437660	4864150

Appendix F. Mean total length, length range, proportional stock density (PSD), and relative stock density (RSD-400 and RSD-500) of rainbow trout captured in the Box Canyon reach electrofishing reach, Henrys Fork Snake River, Idaho, 1995-2010. RSD-400 = (number ≥400 mm/ number ≥200 mm) x 100. RSD-500 = (number ≥500 mm/ number ≥200 mm) x 100.

Year	Number	Mean TL (mm)	Length Range (mm)	PSD	RSD-400	RSD-500
1991	711	293	71 – 675	65	46	9
1994	1,226	313	46 - 555	90	46	3
1995	1,590	316	35 – 630	61	30	1
1996	1,049	300	31 – 574	66	20	1
1997	1,272	307	72 – 630	47	14	1
1998	1,187	269	92 – 532	45	13	0
1999	874	330	80 – 573	63	16	1
2000	1,887	293	150 – 593	45	11	1
2002	1,111	352	100 – 600	75	28	0
2003	599	365	100 – 520	86	42	1
2005	1,064	347	93 – 595	76	44	2
2006	1,200	320	95 – 648	64	26	2
2007	1,092	307	91 – 555	58	21	2
2008	1,417	341	92 – 536	73	20	1
2009	1,371	350	80 – 587	79	27	1
2010	2,700	307	75 - 527	51	23	1

Appendix G. Electrofishing mark-recapture statistics, efficiency (R/C), Modified Peterson Method (MPM) and Log-Likelihood Method (LLM) population estimates (N) of age 1 and older rainbow trout (≥150 mm), coefficient of variation (CV) of N (Log-Likelihood estimate), and stream discharge (cfs) during the sample period for the Box Canyon reach, Henrys Fork Snake River, Idaho, 1995-2010. Confidence intervals (±95%) for population estimates are in parentheses.

Year	M[a]	C[a]	R[a]	R/C (%)	N/reach MPM	N/reach LLM	N/km LLM	CV (%)	Discharge (cfs)
1995	982	644	104	16	6,037 (5,043-7,031)	5,922 (5,473-6,371)	1,601 (1,479-1,722)	3.9	2,330
1996	626	384	69	18	3,456 (2,770-4,142)	4,206 (3,789-4,623)	1,137 (1,024-1,250)	5.1	1,930
1997	859	424	68	16	5,296 (4,202-6,390)	5,881 (5,217-6,545)	1,589 (1,410-1,769)	5.8	1,810
1998	683	425	42	10	6,775 (4,937-8,613)	8,846 (7,580-10,112)	2,391 (2,049-2,733)	7.3	1,880
1999	595	315	38	12	4,844 (3,484-6,204)	5,215 (4,529-5,901)	1,409 (1,224-1,595)	6.7	1,920
2000	1,269	692	74	11	11,734 (9,317-14,151)	12,841 (11,665-14,017)	3,471 (3,153-3,788)	4.7	915
2002	1,050	511	81	16	6,574 (5,329-7,819)	7,556 (6,882-8,230)	2,042 (1,860-2,224	4.6	820
2003	427	167	20	12	3,472 (2,147-4,797)	3,767 (3,005-4,529)	1,018 (812-1,224)	10.3	339
2005	735	401	90	22	3,250 (2,703-3,797)	4,430 (3,922-4,938)	1,197 (1,060-1,334)	5.8	507
2006	887	356	61	17	5,112 (4,005-6,219)	5,986 (5,387-6,585)	1,618 (1,456-1,779)	5.1	1,783
2007	737	332	51	15	4,725 (3,598-5,852)	8,549 (7,288-9,810)	2,311 (1,970-2,652)	7.5	542
2008	887	615	93	15	5,818 (4,842–7,089)	5,812 (5,312-6,312)	1,571 (1,436–1,706)	4.4	894
2009	673	775	112	14	4,628 (3,910-5,540)	5,034 (4,610-5,458)	1,361 (1,246-1,476)	4.3	1,377
2010	1,309	1,292	262	20	6,439 (5,820-7,058)	8,341 (7,857-8,825)	2,254 (2,123-2,385)	3.0	626

[a]M = number of fish marked on marking run; C = total number of fish captured on recapture run; R = number of recaptured fish on recapture run.

Appendix H. Sample site locations in the Willow Creek drainage in 2010.

Stream	Site Name	UTM East	UTM North
Tex Creek	Road crossing	442425	4809167
Indian Fork Tex Creek	Middle	449364	4808851
Birch Creek	Above diversion	435896	4798616
Sellars Creek	Corsi old site 1	437863	4791223
Mill Creek	Corsi repeat	435572	4785095
Hell Creek	1	444637	4797452
Homer Creek	Lower	447509	4790901
Homer Creek	Middle	446494	4789095
Lava Creek	Below NF	457159	4790908
Lava Creek	2005 #007 (lower)	453466	4789342
Lava Creek	Mid #2	453870	4790188
Lava Creek - unnamed tributary	Only site on trib	456157	4791375
Brockman Creek	Mouth	455047	4784591
Brockman Creek	#3	464688	4785922
Brockman Creek	#4	463374	4785856
Brockman Creek	#5	465982	4784593
Brockman Creek	#6	467703	4784009
Brockman Cr - unnamed tributary	2005 #437	467137	4782758
Shirley Creek	Lower	459293	4783481
Shirley Creek	Upper	459416	4782626
Sawmill Creek	2005 #465	459820	4787823
Sawmill Creek	#014 – upper fork	460191	4788225
Sawmill Creek	#1 (2005 #435)	460466	4787763
Willow Creek	High Bridge	437081	4795884

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